POWER

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Make a Note of It

BY what process does the brain retrieve impressions from the storehouse of memory and present them again to the consciousness?

By what sort of a filing system is this motley collection of things heard and seen, read and experienced, in the distant past or at the passing moment, kept on demand to be called up by subconscious impression or conscious effort and fitted into the mosaic that makes the background of consciousness itself?

With a friend I was crossing a city street. As we landed upon the sidewalk he started to hum the air of an old song. The same song was running through my mind when he began to hum it. Something in that confusion of noises and activity had, without any recognizable reason, called it up in both our memories.

Those things that one is able to call up at will constitute his stock of knowledge, and their extent and quick availability have much to do with one's capabilities and usefulness.

But the power of the mind to reproduce upon demand impressions that it has received is limited. Memory is treacherous, and many a good line and useful fact have been sunk in its murky waters.

And so the man who works or plays otherwise than with his hands and muscles finds it helpful to put the more essential of the information, suggestion and thinking that are brought to him upon the current of time on record in a readily accessible form.

And, as the jotting down of a name or a number often serves to fix it in the memory, so the recording and filing of information, suggestion and lines of thought serve to regiment the mental processes in regard to them and to make them more completely consistent factors in one's own thinking.

Man can carry comparatively little of the accumulated knowledge of the race around in his own head. The next best thing is to know, in general, that it exists and where to go to get it.

And the more knowledge that has come to him and been ticketed and recorded for easy reference, the more efficient and capable will he be in meeting the demands of the passing moment or in the deliberative discussion of larger things.

F. R. Low

POWER *Stands for . . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application

Recession of Speculation Is Industry's Opportunity

IN THE opinions of the experts, there is no reason to believe the recent Wall Street débâcle was caused by any unsoundness in business; and convincing facts and figures from all directions add greatly to the support of this view.

To those of us whose lives are joined so firmly to industry this is comforting, for it promises a general return to normalcy and an increased welcome to the industrial builder by capital.

In this aspect there is plenty to stimulate the industries in which an opportunity to economically finance the modernization of their power services will mean increased profits, whether or not they operate their own power plants. There are abundant dividends in the development of highly efficient heat balances with process steam as a part of the power cycle and in the adoption of modern power service appliances. Moreover, "there is no time like the present."

The All-Welded Surface Condenser

IT HAD to come! Recent developments in fabrication of tanks and other engineering structures by the welding process pointed to the early advent of the large all-welded surface condenser. Reductions in weight and first cost were clearly obtainable, and it seemed probable that certain other advantages would result from substituting welded steel for cast-iron construction.

While a few welded marine condensers have been built recently, no land installation comparable with the 27,000-sq.ft. Parr Shoals condenser described on page 786 of this number of *Power* has previously been built. This unit has been in regular operation for two months and has, it appears, fully justified the faith of builder and purchaser. Savings in weight and first cost are definitely established.

At Parr Shoals the saving in weight has made possible the suspension of the condenser shell from the turbine exhaust without even partial counterbalancing by spring supports or other means. This possibility has decidedly modified the design of the whole condenser, which is unique in several respects. With tubes rolled into tube sheets (this, in itself is not new, of course) the water boxes are separately supported and connected to the shell in a way that gives free play to expansion. Those interested will find a detailed description of this construction in the article already mentioned.

In one sense, it is true, the new era in condenser construction presaged by this successful application carries with it certain penalties. Investments in pattern and foundry equipment will inevitably decrease in value. The door will be opened to additional competition. Great organizations must adapt themselves rapidly to a new and by no means simple art. But after all due allowance is made for the pains of transition, it is probable that in the long run the manufacturer will share with the user in the benefits of a process that lowers costs and increases quality. Such, at least, has been the experience in many other fields of manufacturing.

Business and Power in New England

IT IS no strange thing that New England should have been the first section of the country to develop supremacy in business. It was also first in the development of industry. Industrial activity, with the concentration of a consuming public that results from it, is a leading factor in business growth.

Behind the industrial activity, however, there must be a background of natural resources, a supply of essential ingredients of manufacture that permits industry to grow naturally. In one region it may be coal and iron, in another agricultural products, in others the raw materials of chemical production. In New England it was water power and timber.

On these two foundation stones the six northeastern states erected a structure that early made them the workshop of the country and also the business center. Men of that time must have felt that they had reached the ultimate height of achievement, for they soon began to invest their surplus in industry in other parts of the country. Consequently, New York, Pennsylvania and the Middle West took the industrial lead and New England appeared to stagnate.

This was not so. Under the quiet surface the yeast of enterprise was fermenting; and, since the War, it has become apparent that the old Yankee energy and aggressiveness still live. Reforestation is seen on every side, bringing back to production the once depleted forests of white pine. Factories are being re-equipped, rebuilt, reorganized.

Most important of all, power supply is being wholly modernized. The falling waters that made the first development possible are being reharnessed in modern, efficient ways. Steam plants of highest grade are being built at tide water, to take advantage of low fuel cost. Finally, alert and efficient managements are intercon-

necting these power sources so that ample, reliable supplies are available for all industry.

In this revitalization of New England industry, no factor is more important than power.

Paint—A Good Investment for the Power Plant

PAINT has something more than good looks to recommend its use in power plants. Sound economic reasons dictate its extensive application. Making the power plant more pleasing in appearance and a more desirable place to work in can be justified on a dollars-and-cents basis. If the interior of the plant and the equipment are given a harmonious and agreeable color, it will be an incentive to the operators to maintain the condition of the plant at a higher level than if the surfaces are neglected and allowed to remain any old color they originally happened to be.

A color code on the piping will add much to the safety and convenience of operating the plant, in addition to preserving sufaces and improving their appearance. A valve closed or opened by mistake may cause an expensive shutdown of equipment. If the piping for each service is painted a distinctive color, the chances of such mistakes are reduced and the reliability of the plant is increased. The extensive use of aluminum paint has done much to improve the safety of plant operation. A better diffusion of light will brighten up poorly illuminated places. Dark surfaces that are difficult to discern become easily visible when painted a light color. Painting prevents parts from rusting and becoming weaker, and where rusting does develop, it is readily detected by the paint's discoloring.

Painting has created a new era in power plant operation; out of which have come not only a more livable place in which to work, but also increased efficiency, safety, reliability and a reduction in operating costs.

Is It Simply a Matter of Bookkeeping?

"MOST distribution is simply a matter of bookkeeping. Everything used is necessarily paid for somewhere and somehow. We don't see any advantage in a lot of red tape, so we just lump electrical charges, steam, water and other power services, and spread this cost over the departments in the simplest way our accountants can work out"—such arguments are heard every day. Parading under a mask of common sense, they exhibit a type of loose thinking that is causing American industry to lose millions of dollars yearly.

Right at the start let's agree that no academic refinements of cost accounting are justified unless they definitely increase the profits of the business. That is the test of any system of cost keeping.

Keeping this criterion clearly in mind, it is evident that some expenses are properly lumped and spread over all departments in more or less arbitrary fashion. Where the commodity or service used involves only a moderate sum of money, or where the amount used is practically independent of the interest and watchfulness of the department head, precise cost distribution may be an extravagant frill.

But what would one think of an electric company that charged each householder the same yearly sum for electricity, regardless of the amount used? If all the houses in such a village were incorporated into one giant company, what would happen to expenses and profits if each householder could get his coal, gas and electricity at a flat yearly rate? Obviously, lights would stay on all night, gas flames would burn constantly, and windows would be open in winter to offset excess heat from overdriven furnaces.

That the same thing, in effect, happens in public buildings and industrial plants where departments responsible are not charged for electricity, steam, water, etc., is a matter of common observation. Constant inspection, with "kicks" and complaints, will reduce the losses a little for a time, and at the cost of much friction and hard feeling. But, with human nature what it is, no thorough-going reformation of departmental wastefulness is possible except by charging large items, subject to variable consumption, directly to the departments concerned. What is needed in such cases is less talk and more meters.

"Cheap" Water Power

SOME years ago the late John Harper, widely known chief engineer of the Niagara Falls Power Company, remarked that many people think that water power is free. Yes, he would say, that is true, it is free—just like coal, all you have to do is go and get it.

Coal in the ground, water in a lake. Both free for the taking. And both hard to take. On the one hand, mines, railways, handling machinery, stokers, furnaces, boilers, steam engines. On the other hand, dams, penstocks, control works, waterwheels, transmission lines.

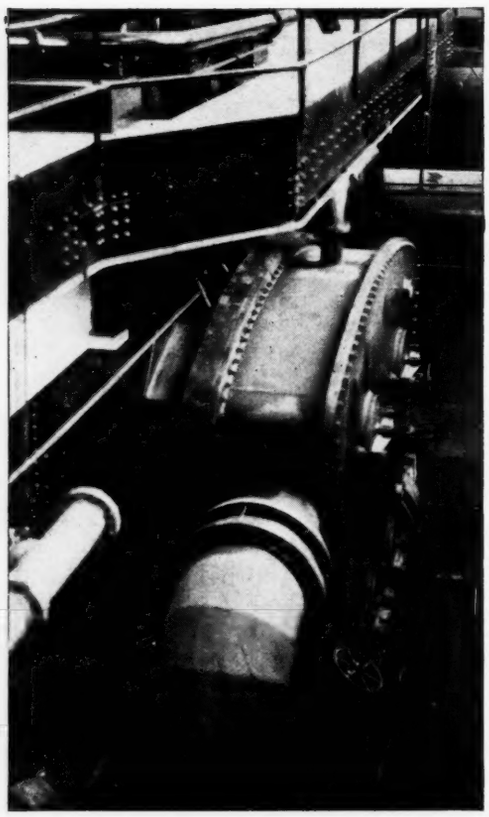
In reckoning the cost of power, it makes no difference whether money is spent for consumable materials, like fuel, or for interest. It is money spent just the same. It is just as painful to send an interest check to the banker as it is to send a check to the coal dealer. And the banker doesn't care what you spend the borrowed money for. Whether it goes into a dam or a boiler house, into a railway or a transmission line—his interest demands are unchanged. And of course the stockholder looking for dividends is "in the same boat" with the banker looking for interest.

Another thing. One cannot build up a market and then leave it stranded for lack of water or fuel. The power developer must provide for a dependable, continuous supply. And that makes a difference too.

On the whole, the present swing seems to be toward the fuel-burning type of plant. The more convenient water power sites are pretty well worked up.

Large All-Welded Condenser

Successfully Operating at Parr Shoals



The condenser serves a 30,000 kw. turbine

The 27,000-sq.ft. surface condenser recently placed in operation at the Parr Shoals station, Parr, S. C., is unique not only because it is the first large all-welded surface condenser built for land use, but also because of a method of construction and suspension that eliminates tube packing, gives complete freedom for thermal expansion and leaves the space beneath the body of the condenser entirely free of structural supports

IN VIEW of the rapid advance of welding in all industrial fields, great interest attaches to the first large all-welded surface condenser for a stationary power plant. It is now in operation in the Parr Shoals station of the Broad River Power Company at Parr, S. C. This condenser, having 27,000 sq.ft. of condensing surface and serving a 30,000-kw. turbine, went into regular operation on Sept. 10 and has since been giving entire satisfaction.

The Parr Shoals plant was erected in 1924. In 1928 the installed capacity was 42,500 kw., consisting of one 12,500-kw. unit and one 30,000-kw. unit. These were equipped with surface condensers of customary construction. Decision was made in 1928 to enlarge the plant by the addition of a 30,000-kw. Westinghouse turbine-generator. At that time the Ross Heater & Manufacturing Company brought to the attention of W. S. Barstow & Company, engineers in charge of operation and construction for the Broad River Power Company, the possibility of gaining certain advantages by substituting welded construction for cast iron. A study of European condenser design and of marine practice over the past twenty years reinforced preliminary impressions that some saving would be made in first cost and that a substantial reduction in air leakage would be effected.

Bids made in October, 1928, showed lower cost for the welded condenser, the saving in first cost and other advantages being sufficient to justify the company in undertaking a forward step of this nature. The contract was awarded to Ross Heater & Manufacturing Company. Design details of the condenser were submitted by the manufacturers and worked out to conform to the requirements of the Broad River station. Some changes were necessary to accommodate the condenser design to the limited head room available for a unit of this size.

Since the selection of a welded condenser for this plant is intimately tied up with available head room and certain other factors, these should be briefly explained before going into the design in detail. In the Parr Shoals plant, the head room from turbine operating floor to basement floor is only 22 ft. Supporting structures beneath the condenser would have interfered with operating accessibility. It was therefore desired to support the shell, at least, from the turbine exhaust flange. The lightness of welded construction naturally favored the use of a hung shell. It was at the same time found possible to make adequate provision for expansion and contraction without the use of tube packing.

In brief, the plan of support is as follows: The tubes are rolled directly into the tube plates at both ends. One water box is supported on a fixed base, while the other is free to slide on a plate provided with Alemite lubrication. The shell itself is bolted directly to the turbine exhaust flange and is attached to both water boxes by rubber expansion joints providing for slight movements in any direction. Interior tube supports of special design prevent sagging of the tubes and transfer to the shell much of the weight of the tubes and the water they contain.

Construction work on the condenser started in the Ross shop around the first of January, 1929. Since railroad clearances made it impossible to complete the fabrication of the shell in the shop, the condenser was made up in six completed sections—four shell sections

and two water boxes. These were shipped around the first of March. Two welders were employed for the joining of the sections and other field welding, which required six weeks in all. Rigging, tubing and delays caused by work on other equipment extended the time of completion until late in June, when the turbine was given a preliminary line test.

Following some minor adjustments, another test was made on July 10. The results obtained are shown in the following table:

Time	1:45 p.m.	2:10 p.m.	4:05 p.m
Load, kw	10,000	15,000	20,000
Steam flow, lb. per hr	111,000	160,000	210,000
Water flow, lb. per hr	23,000,000	22,800,000	22,900,000
Barometer, in	30.07	30.07	30.04
Vacuum at turbine exhaust, in	28.4	28.23	28.05
Vacuum at air offtake, in	28.43	28.27	28.10
Temperature of exhaust, deg. F	94.4	97.5	100
Temperature condensate, deg. F	92	96.5	100
Temperature inlet water, deg. F	85.5	86	86
Temperature discharge water, deg. F. (upper compartment)	90.5	92.75	94.5
Temperature discharge water, deg. F. (lower compartment)	89	91.5	93.5
Log mean temperature difference	6.50	8.03	9.45
K = B.t.u. /sq.ft. /deg. F. /hr. (based on log. mean temperature difference)	600	700	820

It will be noted that the vacuum obtained ranged from 28.4 in. to 28.05 in. This, of course, must be evaluated in the light of the temperature and amount of the circulating water. The vacuums indicated are remarkably good for water inlet temperatures of the order of 85 deg. Of particular significance is the comparison of the temperatures obtained at the turbine exhaust and in the condensate, differences noted ranging from zero to 2.4 deg. It is believed by the engineers that the rolling of the tubes in the tube plates, together with the use of welded construction, are largely responsible for the low air leakage indicated.

After the test there was no immediate need for the new unit. Regular operation, therefore, did not start until around September 10, since which date it has been working satisfactorily.

As has already been pointed out, the matter of weight influenced the decision for a welded condenser in two ways: first, by cutting down the initial cost, and, secondly, by making more feasible the special suspended construction desired to keep clear the floor space beneath the condenser. In connection with this matter of weight it is worth noting that the steel used for the shell of the condenser is $\frac{7}{16}$ in. thick, whereas the corresponding cast-iron thickness would have been of the order of $1\frac{1}{4}$ or $1\frac{1}{2}$ in. To guard against corrosion it was decided to build the condenser of copper-bearing steel.

The general design of the condenser is shown on page 788. In transverse section it is heart shaped, with radial tube lanes converging toward a point below the bottom of the condenser. The ability to obtain a light structure for the shell made it feasible and desirable to use a larger shell than is customary for a condenser with the same amount of condensing surface, in order to permit a wider spacing of the tubes. This, in turn, results in lower pressure loss through the condenser and in higher condensate temperatures.

The construction of the shell is similar to that employed in shipbuilding. Butt joints are reinforced with T-bars (5 x 5 in.) both inside and out. The inside bars, as may be seen from the drawing, run up and down, while those outside run longitudinally,. A greater equivalent section modulous might have been obtained by attaching the reinforcing T-bars to the shell at the end of the center leg rather than at the two edges of the head, but the latter construction was adopted as more feasible mechanically in the present stage of the art. Necessarily, fillet welds were used to attach the T-bars.

All joints in the sheet itself are double V-butt welds. All welds were made by the stable-arc process.

Copper-bearing iron, rather than the usual Admiralty or Muntz metal, was used for the tube plates. The tube plates are $1\frac{1}{4}$ in. thick, the tubes having an outside diameter of $\frac{3}{4}$ in. (17 gage). The tubes, of Admiralty metal, were ordered with the inlet ends rounded to approximately $\frac{3}{8}$ in. radius, the inlet tube plate being machined at the tube holes to fit this curvature. After the tubes were in place they were rolled inside of their cylindrical contacts.

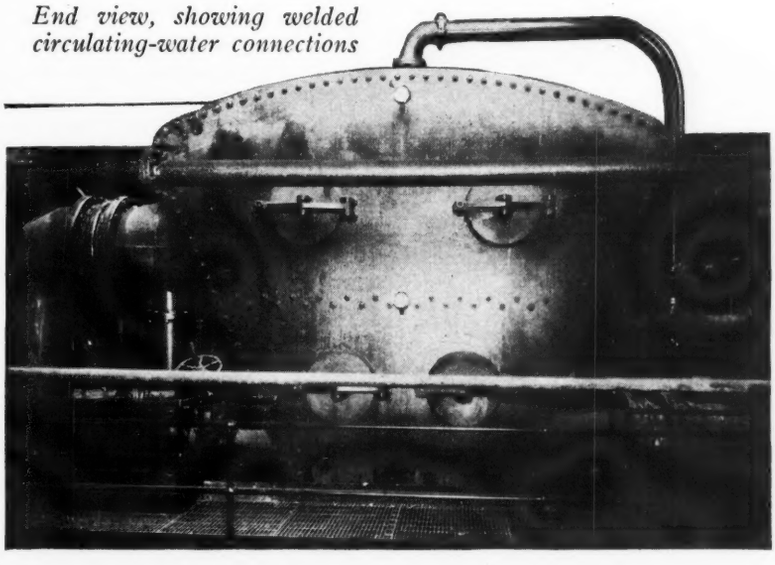
The six sections fabricated at the shop have the following approximate shipping dimensions: 5 ft. 6 in. long, 13 ft. high and 15 ft. wide, except that the end sections are somewhat lower. The outside shell for each of the four main sections is made of three pieces, one piece being used for the bottom curved portion and one for each side. Side pieces are straight except for two bends, as shown in the upper portion of the condenser.

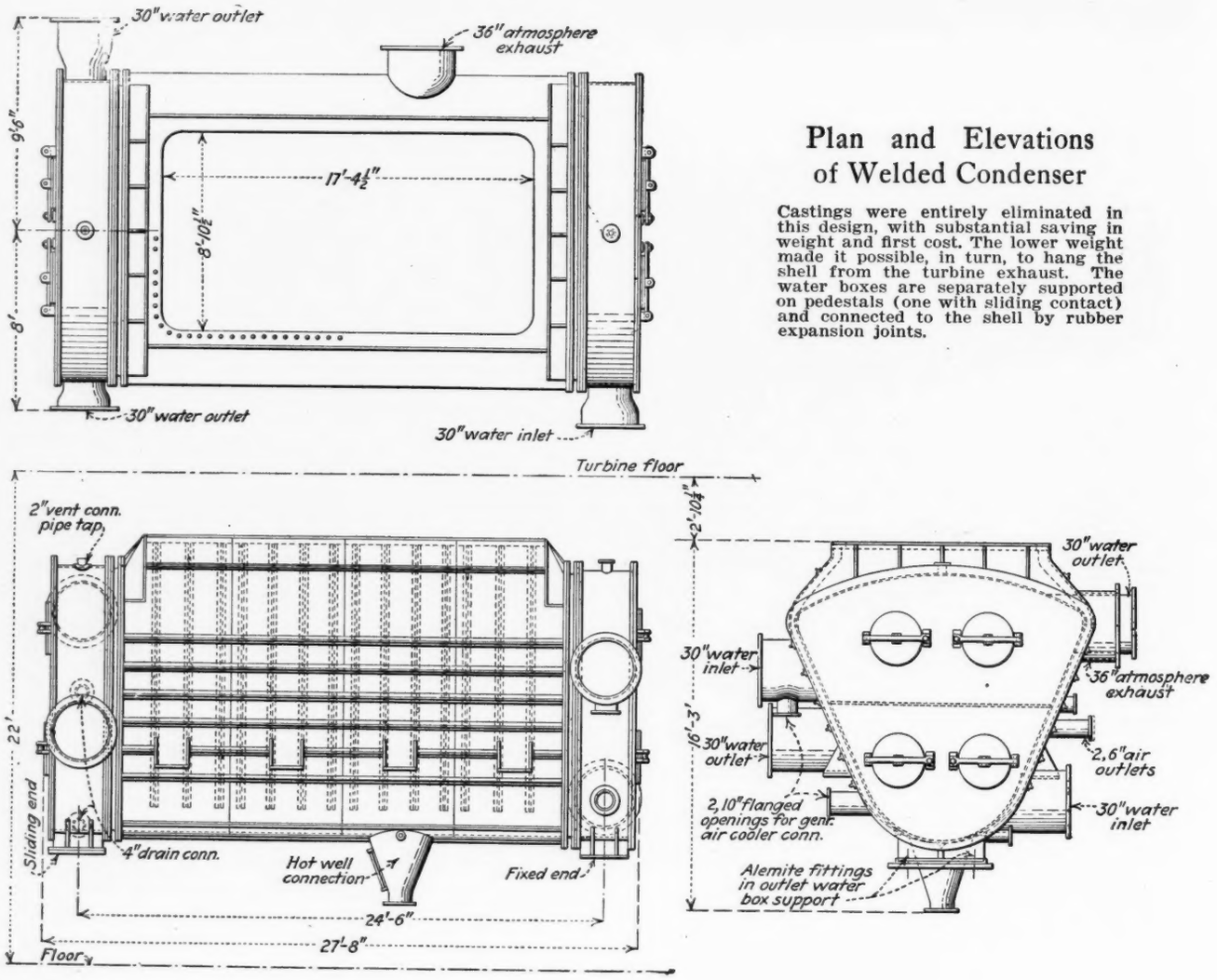
Aside from the girth seams connecting the sections, the only field welding that had to be done was the attachment of the longitudinal reinforcing T-bars and certain connections such as the hot-well nozzle at the bottom of the shell.

Horizontal partitions in the water boxes divide the condenser water space into upper and lower sections for cleaning. The outside plates of these boxes are similar to those of the main shell. Flanges at both ends of each box were necessary, since one end had to be connected to the rubber expansion joint, while the cover plate on the other end had to be removable to permit access to tubes. Each of these four flanges was formed from six pieces, the flange section being 1 in. x 5 in. The small curves were cut from rings, while those of larger radius were bent from bars. After welding, the flanges were machined to give a bearing surface.

Cover plates of copper-bearing iron, $1\frac{1}{2}$ in. thick, are used. They required no welding beyond the attachment of clevis and holding bolts for the manhole covers, together with rings for cover seats. To

End view, showing welded circulating-water connections



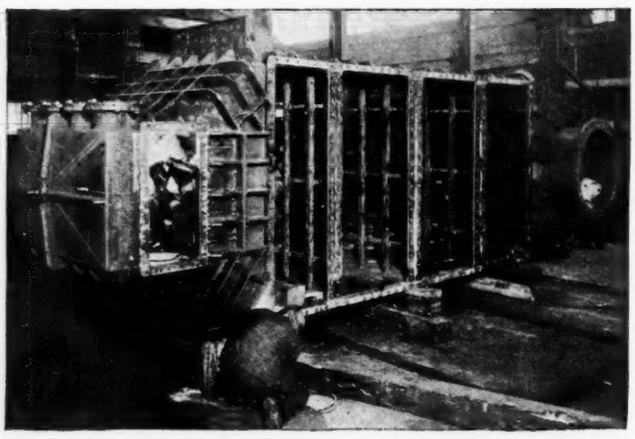


Plan and Elevations of Welded Condenser

Castings were entirely eliminated in this design, with substantial saving in weight and first cost. The lower weight made it possible, in turn, to hang the shell from the turbine exhaust. The water boxes are separately supported on pedestals (one with sliding contact) and connected to the shell by rubber expansion joints.

insure tight joints, thick soft-rubber gaskets are used between the manhole covers and their seats.

Each section of each water box is provided with one 30-in. circulating connection, making four in all. These are welded, as are all other connections on the condenser. The cross-section of these connections changes gradually from the circular section at the outer flange to elliptical at the junction point with the water box.



This photograph of a gasoline condenser in the Ross plant shows the type of construction required in welded steam condensers

This is necessary because the water box thickness is less than the diameter of the pipe connection.

Flanges on circulating-water connections are $1\frac{1}{2}$ in. thick and designed in accordance with the A.S.M.E. standard for low pressures. Each water box was assembled complete in the shop. The hot-water nozzle, in the form of an inverted frustum of a cone, was fabricated in the shop and attached in the field by a single weld.

Air is removed by a Ross two-stage ejector, with inter and after condensers. Cooling water is taken from either the top section of the inlet water box or the lower inlet circulating-water connection.

The fabrication and attachment of the exhaust inlet end of the condenser presented an interesting structural problem. It was necessary to attach the flange to the condenser in a way that would insure the condenser (with its connections) being truly horizontal in both directions after bolting the exhaust inlet flange to the turbine. It was done as follows:

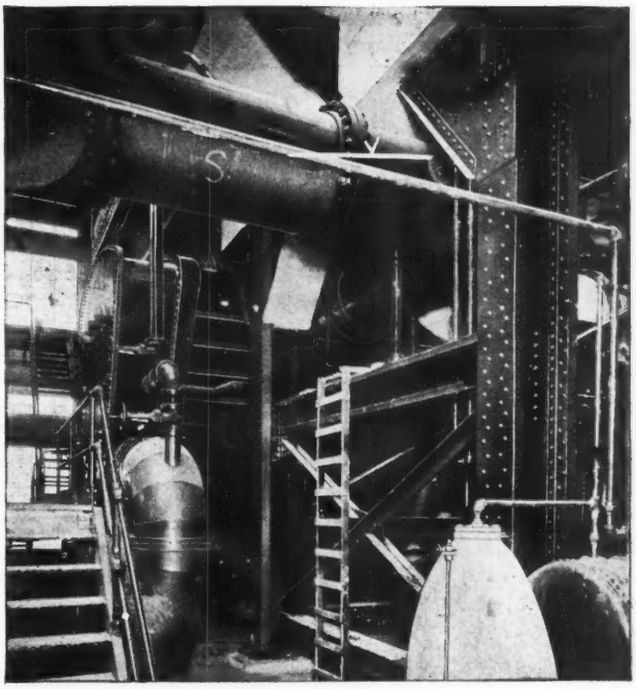
The flange was shop-fabricated from copper-bearing iron by welding gas-cut curved corner pieces to four straight strips of bar stock. This material was sized for machining to a flange section of $7\frac{3}{4}$ in. x 2 in. thick. The flange was then bolted to a structural frame, after which the contact surface was machined and the holes drilled. Then, with the structural frame still attached, the flange was shipped to the job as a unit. In the field fabrication the condenser sections were first lowered to the basement

floor, thus providing several feet of clearance beneath the turbine exhaust flange. By means of distance pieces and clamps (with the structural frame still attached) the flange was set rigidly below the turbine flange, with the surfaces parallel and the bolt holes aligned. Next the condenser shell sections were lifted, one at a time, by jacks, until they reached the proper position in relation to the exhaust flange, after which they were welded to the flange.

When this operation was completed for all the sections the girth seams between sections were butt-welded. The completed shell was then raised and supported by bolting the flanges together, after providing a rubber-gasketed joint between the turbine exhaust flange and the condenser inlet. The outside horizontal reinforcing T-bars were then welded in place, the inside vertical bars having been shop-welded in the individual sections.

While it is too soon to make a final appraisal of this radically new type of condenser construction, it is already obvious that a definite advance has been made, and it seems highly probable that welded construction of condensers will soon come into general use.

Acknowledgment is made to W. S. Barstow & Company and to the Ross Heater & Manufacturing Company for co-operation in furnishing drawings and photographs and for the engineering information on which this article is based.



This view shows the horizontal reinforcing "T" bars and the welded circulating-water piping

DESIGN OF INJECTION SYSTEM DETERMINES FUEL CONSUMPTION

The author claims that tests he has run prove that the variable-stroke fuel pump is superior to the bypass controlled pump for high-speed solid-injection Diesels.

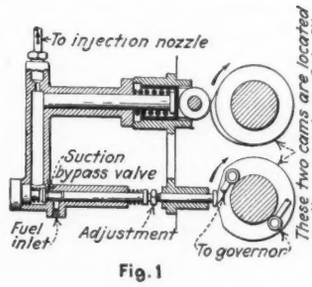
By Alfred Peters

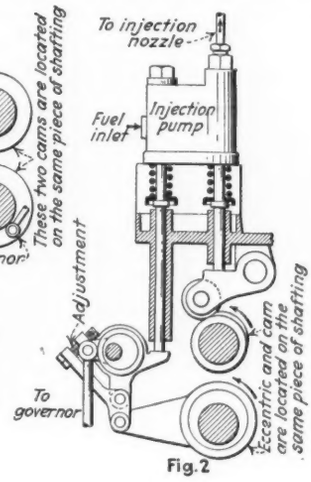
DIESEL ENGINES of the "air-less," or solid-injection, type employ fuel pumps of the variable stroke and the bypass design. Both work satisfactorily, but there are mechanical advantages inherent in the variable-stroke pump that make this design preferable for small, high-speed engines.

The bypass mechanism requires delicate adjustments, particularly with small, high-speed engines having more than one cylinder, for the fuel requirements per stroke are almost infinitesimal in volume. Machine shops are unable to machine the injection pumps and the component parts exactly alike; for example, it is impossible to make the valve seats exactly the same distance from the shaft that moves them. Furthermore, in regrinding, the seat of one valve will be cut deeper than that of a second valve, which, of course, will change the distance. Compensating adjustments must be made, which is particularly undesirable with small engines in the hands of inexperienced operators. In large plants, when the engineer is a good mechanic, the objection is not so great.

The foregoing statements are backed by experiments run on a two-stroke-cycle, 650-r.p.m. engine with four cylinders of 5.5 in. bore and 6.5 in. stroke, rated at 30 b.hp. The fuel pump first tested is that shown in Fig. 1, with a governor-controlled suction bypass valve.

The engine was of the low-compression type and was expected to have a fuel consumption of 0.7 lb. per brake-horsepower-hour, but it was always difficult to obtain this figure, not because the engine itself was uneconomical,





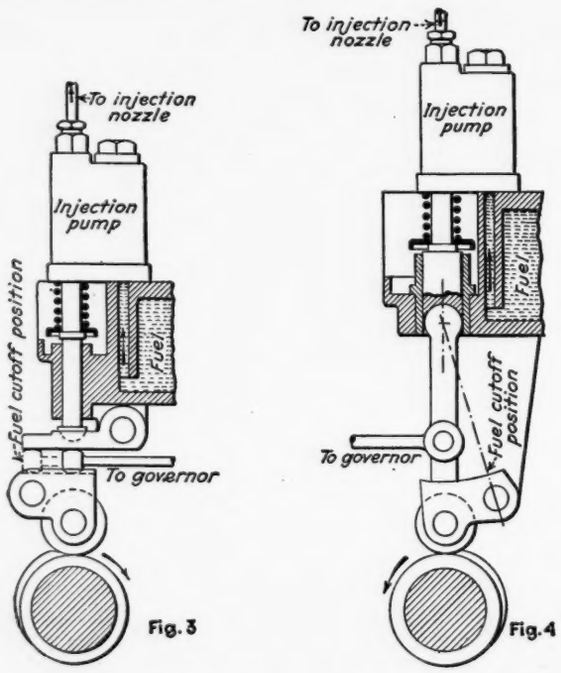
Figs. 1 and 2—Two types of fuel-injection pumps with suction bypass control

but because the tester was unable to adjust the fuel pump mechanism to distribute the fuel equally among the cylinders.

This defect was revealed by tests on a single-cylinder engine of the same cylinder dimensions. It was found that a change of pump adjustment had no influence save that it altered the position of the governor sleeve, resulting in a slight change in speed. This single-cylinder engine had an actual fuel consumption of from 0.58 to 0.62 lb., and with a satisfactory pump there was no reason why the four-cylinder engine should not have performed equally as well.

It has been assumed that a governor and fuel-injection mechanism as in Figs. 3 and 4 would not be as economical in fuel consumption as the bypass types shown in Figs. 1 and 2. The reasons given were slow injection, particularly at slow speed and low loads, due to the profile of the cam being the same from zero to full load. This was disproved by measuring the fuel consumption and making the following check-up:

With the installation of the constant-stroke and bypass mechanism, the governor was equipped with a suitable



Figs. 3 and 4—Variable-stroke fuel-injection pumps favored by the author

pointer and dial, thus indicating its sleeve position under any definite load and speed. When testing, the governor weights were pried out to the position indicated on the dial during the test. The weights were then locked. Tramming the engine under this condition, it was shown that the suction valve actually closed two degrees after the cam follower roller had passed the highest point of the cam. This illustrated conclusively that the suction valve did not seat abruptly at a presupposed point, but that the fuel actually split up into two streams during the time all of it was supposed to be injected into the cylinder.

But why should it not be so? The suction valve of the bypass pump is not mechanically seated, but is seated by the fluid pressure and a light spring. Furthermore, there is a time when the resistance to the fuel escaping around the suction valve is equal to the resistance in the spray nozzle. When this occurs there is no reason why the fuel should not partly be discharged through the nozzle and partly escape around the suction valve. This is exactly what happens; and in the above test the suction valve was shown to be open during the entire period of injection action of variable stroke pump.

Action of Variable-Stroke Pump

With the variable-stroke system all of the fuel is forced through the spray nozzle into the cylinder, whatever the lift of the plunger may be; and while the time, compared with the cam profile, may appear to be longer, it is possible that the actual period of injection is shorter than with the split-up system. If so, the injection also is more forceful.

This is a probable reason why, with the bypass pump, long-injection piping has a detrimental effect on fuel economy. This is not nearly so evident with a variable-stroke pump and is a point of extreme importance.

To obtain a comparison of the two fuel-injection mechanisms, the 5.5x6.5 in. four-cylinder engine was equipped with the variable-stroke pump shown in Fig. 4. No adjustments of any kind were provided, but after ascertaining the actual lifts of the four plungers it was found that a variation of from 0.000 to 0.003 in. existed. On test the following results were obtained (for comparison, the fuel consumption of the single-cylinder engine with constant pump stroke and bypass also being given); the values are the fuel consumption per brake-horsepower in pounds per hour.

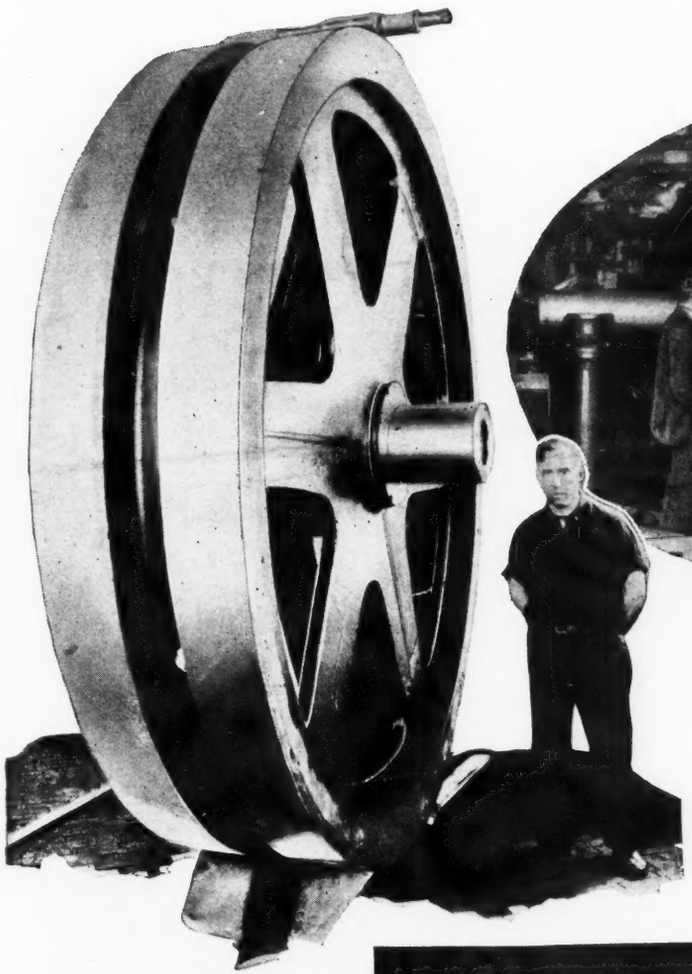
Load	Full	¾	½	¼
Four cylinder, with variable stroke	0.55	0.6	0.73	1.33
Single cylinder with constant stroke	0.60	0.7	0.9	1.45

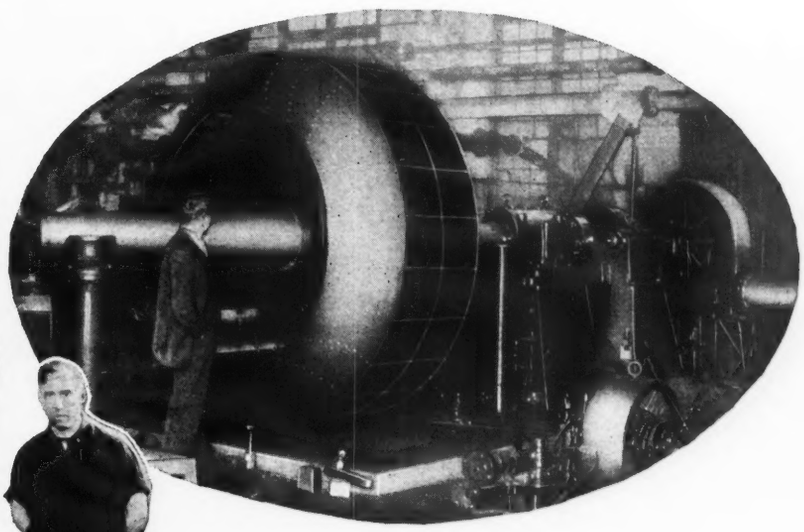
This not only demonstrates the superiority of the variable-stroke pump with regard to elimination of field trouble due to its being free from adjustments, but also shows that it is considerably more economical than the bypass type. The chief advantage of the variable-stroke pump becomes evident in actual service.

There are no really reliable means to gage the load distribution of a multiple-cylinder engine. Pyrometers or thermometers have been used for this purpose, that is, to measure the exhaust temperatures for each cylinder, and it is naturally assumed that uniform temperatures indicate uniform load distribution. It is questionable whether such means are reliable, certainly not unless pyrometers are calibrated from time to time and the elements reaching into the exhaust openings kept free from soot. But granting, if everything functions properly, that the exhaust temperatures are true indicators of the load carried by any particular cylinder, these temperatures depend on other things than the quality of fuel injected. Late injection, poor compression, leaky pistons, leaky gaskets, etc., contribute considerably. The natural tendency is to adjust the fuel to obtain equal temperatures, but there is no proof that equal temperatures mean equally distributed loads. After all, pyrometer equipment is too large a factor in the cost of a small engine and cannot be favorably considered from that standpoint, even if all else were in its favor. Therefore it is far more practical to design a fuel-injecting mechanism that without adjustments will give very closely the same amount of fuel to all the cylinders. If a cylinder does not function properly the real cause of the trouble—such as leaky pump valves, leaky pump plungers and barrels, faulty spray action or poor exhaust conditions—should be located, instead of increasing the amount of fuel, which will only make matters worse.

POTENTIAL POWER

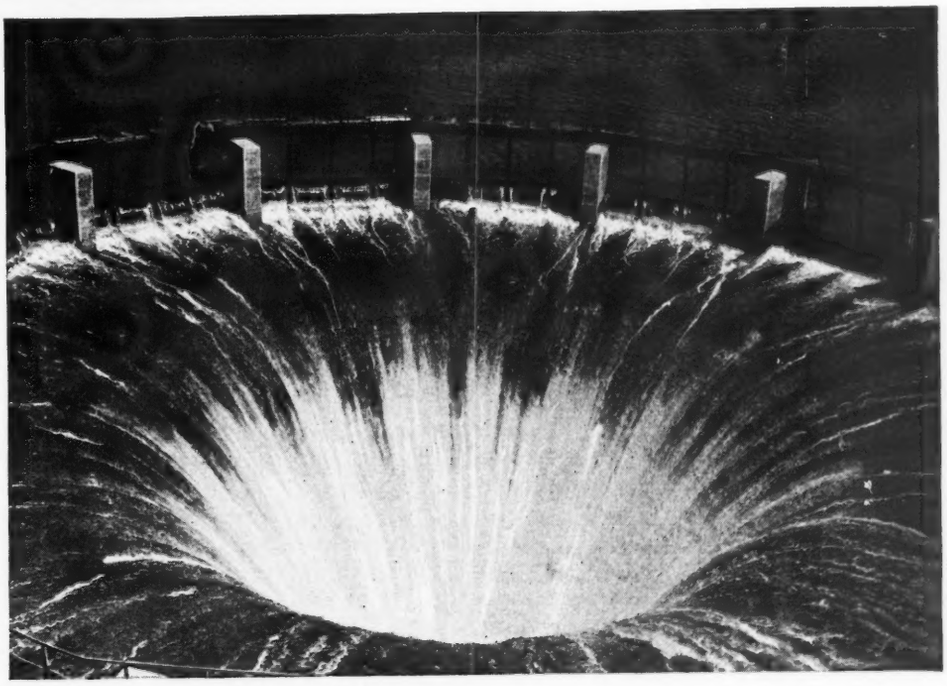
...in Dynamic Curves



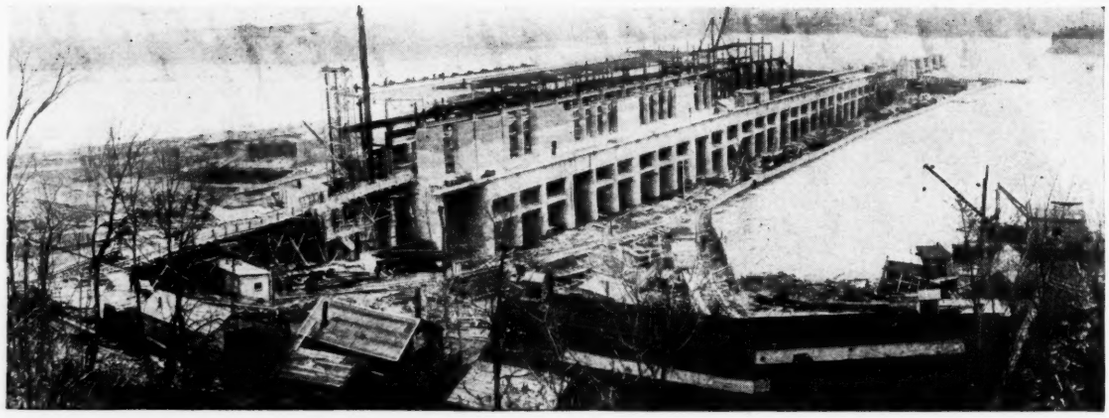


A record-breaker among induced draft fans, this "Turbovane" fan in the New Gorgas Station of the Alabama Power Company delivers 358,000 c.f.m. at 18 in. static pressure. It is driven by an 1,800-hp. induction motor

A speed reduction of 26.57 to 1 is accomplished in one step by this gear and pinion on a turbine-driven pump in the Howard Bend Pumping Station. The pitch diameter of the gear is 10 ft. 2.9 in.



The "morning glory" spillway at the New England Power Association's Davis Bridge Reservoir, Whitingham, Vermont, proves worthy of its name



Propeller-type waterwheels in this plant will operate under 18- to 26-ft. head

Adjustable-Blade Runners *Increase* *Hydro Plant Output*

By J. F. Roberts
Hydraulic Engineer
Power Corporation of Canada, Ltd.

THE PLANT IS DESIGNED *for ten 12,000-hp. units at 26-ft. head. Six are being installed. Adjustable-blade propeller runners allow increasing the output of each nearly 2,000 hp. during low-head high-water conditions. Two units have ejectors in the draft tube to increase the runners' output during high-water conditions.*

THE Back River development of the Montreal Island Power Company, about eight miles from the city of Montreal, is designed to operate under a normal head of 26 ft. and to develop a continuous output for about 65,000 hp. There are very few power sites capable of producing power in such a large quantity within a radius of eight miles of a city of one million population. For this reason the development is particularly interesting, as it practically eliminates transmission line charges and possible outages. Designs and supervision of construction are being carried out by the Power Corporation of Canada, Ltd.

The Ottawa River has a drainage area of some 56,000 square miles and enters Lake of Two Mountains from the west, Fig. 2. From the lake there are four natural outlets leading to the St. Lawrence River. Two of these outlets go directly into the St. Lawrence at Vaudreuil and St. Annes, with a drop of from five to eight feet. A third outlet is the Back River, approximately 25 miles long, which passes to the north of the Island of Montreal. The fourth and smallest of the outlets is the Milles Isle River, which is about eight miles north of the Back River.

An interesting and somewhat unusual condition is that at certain periods of the year the direction of flow in the Vaudreuil and St. Annes' channel is reversed. This is caused by the accumulation of frazil and anchor ice in Lake St. Louis on the St. Lawrence, raising Lake St. Louis' level above that of Lake of Two Mountains. The change in level causes water from the St. Lawrence to flow into the Ottawa, with the result that the discharge of the Ottawa, plus a portion of the flow of the St. Lawrence, goes down the Back and the Milles Isles Rivers. A considerable increase in flow is obtained in the Back River during part of the low-water period. Whether or not this reversal of flow will continue after the full development of the St. Lawrence is doubtful. With the development of power and the elimination of the flow over the open rapids, the amount of frazil and anchor ice formed will be considerably reduced.

Fig. 5 shows the distribution of flow in open-water seasons through the four outlets from the Ottawa River into the St. Lawrence. During high water, when the flow of the Ottawa River exceeds 300,000 cu.ft.-sec., the flow of the Back River is about 35 per cent of the total, about 105,000 cu.ft-sec. During dry periods, when the flow drops below 40,000 cu.ft-sec., the Back River receives from 60 to 75 per cent of the total. This unequal natural variation in distribution of flow has certain advantages in that it decreases the amount of flood water to be bypassed at the Back River development. The reversal of flow in the Vaudreuil and St. Annes channels sometimes occurs when the electrical load around Montreal is the heaviest.

With present conditions it is estimated that there is a continuous flow of from 22,000 to 25,000 cu.ft.-sec. available for the Back River development, and it seems safe to consider that, as storage on the upper Ottawa increases, the ultimate continuous flow will be in the neighborhood of 27,000 cu.ft.-sec. In the upper stretches of the Ottawa River there are a number of important reservoirs. The principal ones are:

Quinze Reservoir, on the Upper Ottaw River	40,000,000,000 cu.ft.
Temiskaming Reservoir, on the Upper Ottawa River	42,000,000,000 cu.ft.
Lady Evelyn Reservoir, on the Montreal River	10,000,000,000 cu.ft.
Kippawa Reservoir, on the Kippawa River	67,000,000,000 cu.ft.
Mercier Reservoir, on the Gatineau River	100,000,000,000 cu.ft.
Cabonga (now under construction) on the Gatineau	45,000,000,000 cu.ft.

Some of the water used in the Back River development has previously passed through from one to four of the other plants operating under control of the power corporation. These include the Quinze plant, just below the Quinze reservoir on the Ottawa River, and four of the plants of the Northern Ontario Power Company, on the Montreal River.

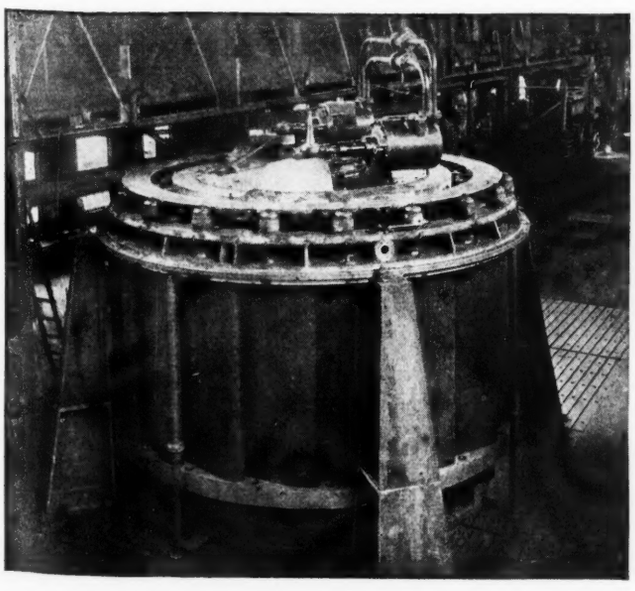
The power house for the Back River development extends out about 750 ft. from the north shore and is designed for ten 12,000-hp., 10,000-kva. units. South of the power house there are thirteen 40-ft. sluice gates and then about 250 ft. of concrete dam section extending to Cedar Island. This island, a small wooded mound of sand, gravel and clay about 150 ft. maximum width, extends about 45 ft. above the bed of the river. On account of the large amount of sand it was necessary to put a concrete dyke along the upstream face of the island. From Cedar to Visitation Island there is a concrete gravity section dam. In this section an opening sixteen feet wide has been left in the hope that at some time it will be possible to erect a Canadian hydraulic testing laboratory there.

Across from the head of Visitation Island to the south shore there is a concrete gravity dam, and for about 5,000 ft. along the south shore a protection wall is required, this consisting of steel sheet piling with corewall and earth-fill sections above it.

A feature of this development is that as the flow increases the head on the plant decreases. This is caused not only by a rise in the tailwater level, but also because the headwater level at the power house must be drawn down with increased flow. This has to be done so as not to exceed a given maximum water elevation at Bordeaux Bridge, approximately four miles upstream from the power house. With a flow of 25,000 cu.ft.-sec. the head on the plant will be about 27 ft. with headwater at elevation 56 ft. and tailwater at elevation 29 ft. When the flow reaches 90,000 cu.ft.-sec. the tailwater will have risen to approximately elevation 35 and the headwater will be drawn down to approximately elevation 53 in order not to exceed the natural water level of elevation 59.8 at the Bordeaux Bridge.

Fig. 1—Guide vane and cover plate assembly for one of the waterwheels

The guide vanes are 8 ft. 5 in. high; the bolt circle for the guide vane stems is 19 ft. 2 in. in diameter, and the cover plate is 21 ft. 6 in. in diameter.



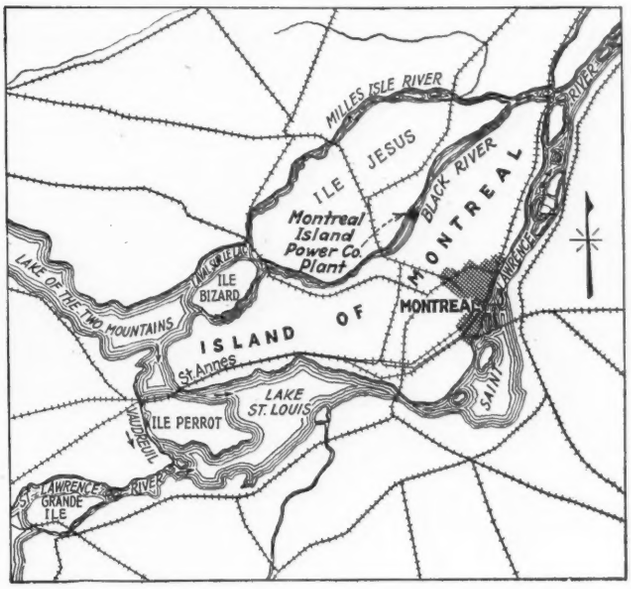


Fig. 2—River system near Montreal and location of power house

At the present time six main units are being installed, these being the largest propeller turbines in physical dimensions of any installed either in Canada or the United States. Three of these are being built by the Dominion Engineering Works and three by the Canadian Allis-Chalmers Company. They are rated 12,000 hp. maximum, 8,800 hp. at best efficiency, 26-ft. head and 85.5 r.p.m. All six of the turbines are provided with manually adjustable blade runners and with these set in the position for maximum power the turbines will each be capable of delivering 12,000 hp. maximum at 26-ft. head and 7,150 hp. at 18-ft. head.

The Allis-Chalmers turbines have four-bladed runners, and the Dominion Engineering Works have six-bladed runners. The runner adjustment on both is made through a gear and internal shaft from a connection applied at the turbine couplings, where a spacer piece, containing the operating mechanism, is mounted between the turbine and generator shafts. It is estimated that a shutdown of approximately five minutes will be sufficient to change any of the turbines. The adjustable-blade runners were adopted for this installation to compensate for the reduction in output during flood periods, when the head drops from 27 to 18 ft. During the low-flow periods it will be necessary to operate the turbines at their best efficiency in order to obtain the maximum output from the water. A fixed-blade turbine rated 8,800 hp. at best efficiency and 26 ft. head would only develop about 5,300 hp. under 18 ft. head. Six such turbines would develop 53,000 hp. at

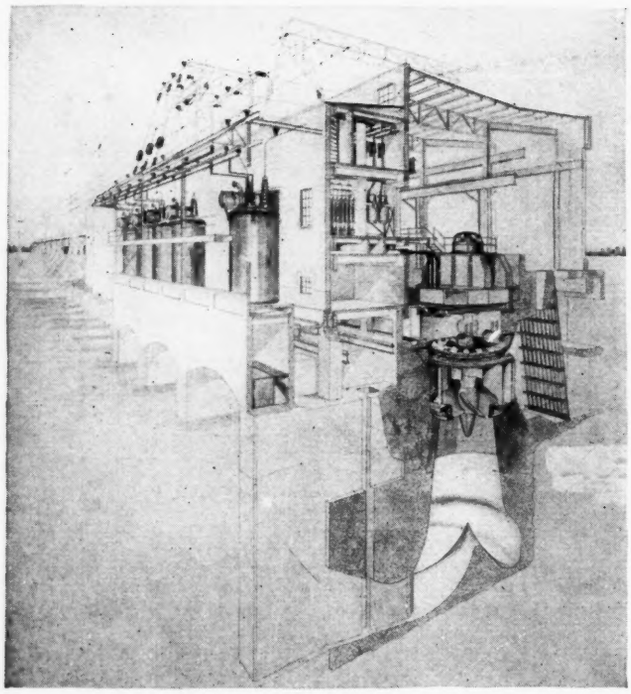


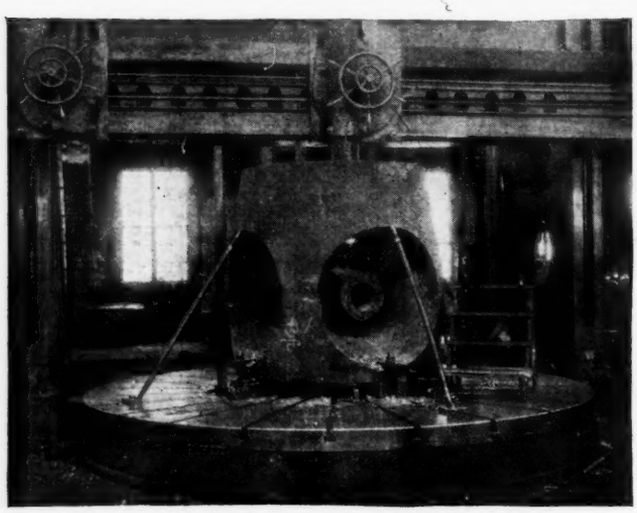
Fig. 3—Transformers to step the voltage up to 66,000 volts are located over the tailrace

26 ft. head, but during flood periods, when the head is reduced to 18 ft., they would be good for about 32,000 hp. By means of the adjustable-blade runners the output is increased from 32,000 to approximately 43,000 hp. with the same number of machines and with comparatively slight additional expense.

In addition to the increased capacity to be obtained during low-head conditions by adjusting the runners' blades, two of the six turbines now being installed are being equipped with ejectors or underwater sluices, Fig. 7. It is expected that the ejectors will increase the output of each turbine approximately 1,000 horsepower.

These ejectors consist of two 8 ft. 3 in. high by 12 ft. 6 in. wide submerged passages connecting directly from the intake at the upstream side of the power house to the draft-tube chamber. The flow through these passageways is controlled by motor-operated gates equipped with fixed rollers. It is estimated that the two gates on a unit will pass about 5,700 cu.ft.-sec. in addition to the 4,400 which each turbine will discharge under 18-ft. head with the maximum power setting of the runner blades. The ejectors have an additional advantage in that being submerged about 25 ft. below headwater elevation they are free from danger of freezing. From the control button on the switchboard these gates can be opened in approximately three minutes.

Fig. 4—Hub weighing 25,000 lb., for one of the runners with adjustable blades, being machined



Before the ejectors were adopted the engineers of the power corporation set up and tested a model of the Back River power house, in order to determine the benefits to be expected. The model was one-fifteenth the size of the actual development, and duplicated exactly all the water passages on one unit, this including the intake, spiral casing, turbine with adjustable-guide vanes, adjustable-blade runner and the draft tube. About seventy-five different tests were run, and many variations of ejector passages were tried, before the form finally adopted was developed.

These ejector passages are somewhat similar to the discharge tubes used in some of the plants of the Consumers Power Company and the Detroit Edison Company in Michigan. Those discharge tubes, however, were installed primarily for discharging flood waters and no attempt was made to increase the power output.

The Back River plant probably is the first installation to utilize the ejector principle to increase the runner's output. For this reason, very careful tests were necessary, as no previous test data were available.

The three Dominion Engineering Works turbines will be equipped with rubber-lined water-lubricated steady bearings of the Goodrich Cutless type. On the Allis-Chalmers turbines the main bearings will be of the adjustable lignum-vitae type, lubricated with water.

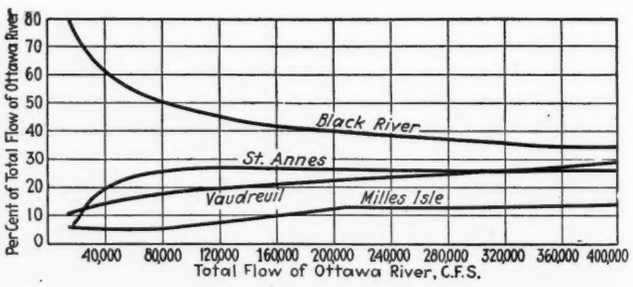


Fig. 5—Curves show the flow of the Ottawa River through its four outlets to the St. Lawrence River

For the six units now being installed the governors will have motor-driven flyballs and will be located on the generator floor alongside the generators. The governors on the three Dominion Engineering turbines will be built by the Woodward Governor Company and the remainder will be built by the Allis-Chalmers Company. Oil will be used as pressure fluid for the governors, the pressure being maintained by an individual motor-driven pump for each unit. In addition, the units will be interconnected in groups of three, and one spare pump provided for each of the two groups, so that in an emergency any three units may be operated on a common or interconnected system.

All six generators now being installed are furnished by the Canadian General Electric Company, and are rated 10,000 kva. 12,000 volts, 3 phase, 60 cycle, 85.5 r.p.m. with 250-kw. direct-coupled 250-volt exciters. The total weight of the generator rotor, shaft, turbine

shaft, runner and hydraulic thrust will be carried on a spring-type thrust bearing mounted above the generator. The generators will have two steady bearings, one above and one below the rotor and the oil for these bearings will be circulated by a dual system. This system consists of a gear-driven gear-type oil pump mounted in the lower generator bearing housing, with a motor-driven gear-type pump as stand-by for emergency service.

The switchboard will be located in the gallery slightly above the generator floor approximately in the center of the power house on the downstream wall. Fig. 3 shows a perspective drawing and a section through the power house. The main leads from the generator will pass upward to the low-tension oil switches located in cells downstream from the generator room and will tie into low-tension busbars above the switches. The main busbars connect to the low-voltage side of three 15,000-kva. single-phase transformers to step up the voltage to 66,000 for connecting to the Montreal Light, Heat and Power Company's system, about five miles south of the power station.

The headgates are 15 ft. wide by 25 ft. high. There are three for each unit. Provision is made for steel stoplogs of approximately the same dimensions and interchangeable with the headgates, to be located upstream of the trash rack. All of these will be raised and lowered with a master log by the gatehouse cranes. At the present time only four units can be stopped off with steel gates, and with the ultimate ten units installed it is not contemplated that additional gates will be required. When not in place the gates will be stored in one end of the gate house. In addition two sets of steel tailrace stoplogs are provided for unwatering the draft tubes.

South of the power house there are located thirteen sluice gates, each 40 ft. wide, with sills at elevation 34, crest at elevation 58 ft. With normal headwater at elevation 56, tailwater at elevation 29, each one of these gates will pass approximately 15,000 cu.ft.-sec. Under

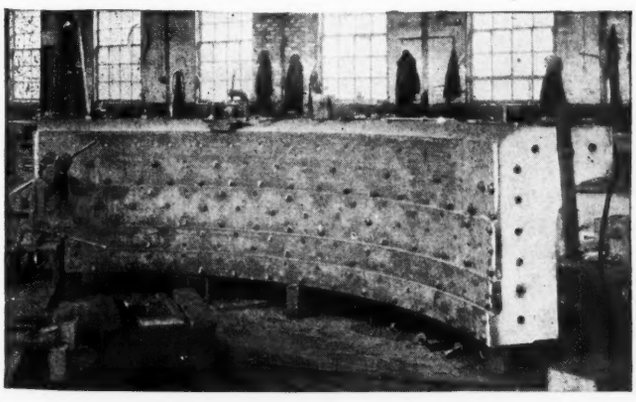


Fig. 6—Section of the discharge ring with renewable steel-plate liners for one of the turbines

reduced head with tailwater at elevation 35 and headwater at 53 ft., it is estimated that the thirteen gates will pass more than 150,000 cu.ft.-sec. The highest flood of which there is any record at the Back River appears to have occurred in 1878 and is estimated at 126,500 cu.ft.-sec. The flood that occurred in the spring of 1928 is the next highest of record and reached a maximum of about 110,000 cu.ft.-sec. With the increased storage now being developed on the upper Ottawa it would appear that future floods would be of less volume than in the past, but provision is being made for approximately 40 per cent greater capacity than the 1928 flood.

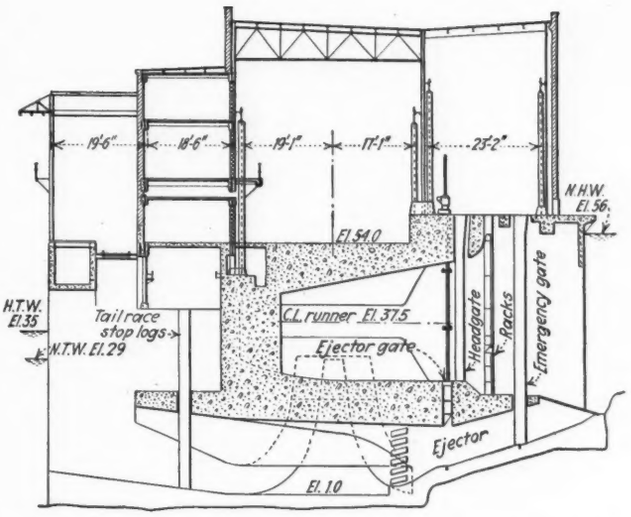


Fig. 7—Two of the units have ejectors that connect the turbine intake with the draft tube

During high water it is expected that these ejectors will increase the output of the two turbines about 1,000 hp. each.

All of the 40-ft. sluice gates will be boxed in on the downstream side, with provision for electric heaters and blowers. In addition to the heating, a bubbler system is contemplated to keep the ice from adhering to the upstream face of the gates. The embedded parts of the gate guides are so made that heating elements can be lowered into them. With these precautions the gates can be operated at a moment's notice throughout the winter. Each gate is provided with its permanent hoist and in addition there is one set of steel stoplogs for the sluice gates, with a traveling stoplog hoist, so that the stoplogs can be dropped in front of any sluice gate in case it is desired to remove it for repairs or painting.

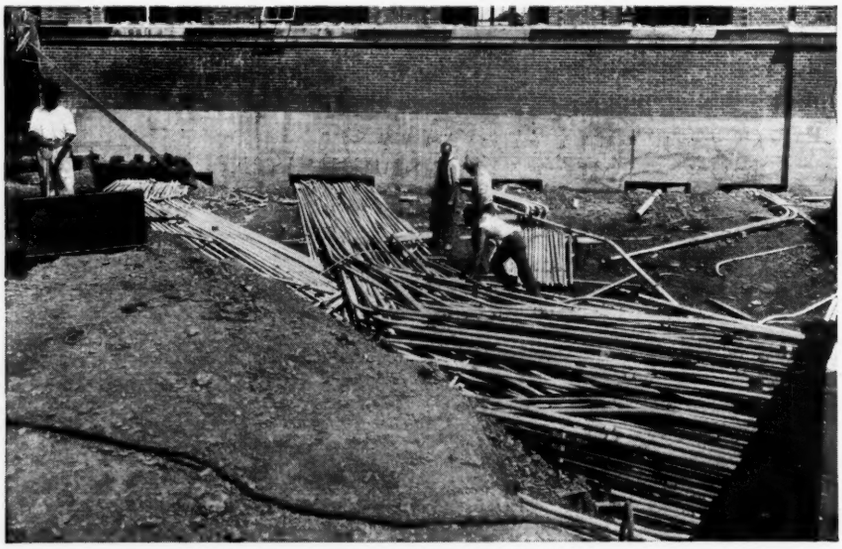
A Legal Phase of Employment

By Arthur L. H. Street

THE body of an Iowa power plant fireman was found lying on horizontal pipes on a balcony in the boiler room. Evidently he had been electrocuted through contact with an iron conduit that was affected by a short circuiting of wires. But just why he had gone onto the balcony was not apparent, although there was some indication that he may have gone there to open a mindow that ventilated the room.

His widow's claim of right to an award under the Iowa Workmen's Compensation Act was opposed by the employer on the ground that the accident had occurred beyond the scope of the fireman's employment. Upholding an award, a majority of the Iowa Supreme Court decided that there was sufficient showing that the death occurred in the line of the deceased man's employment, saying, in part:

"An accident to an employee may arise in the course of his employment, although he is not actually working at the time of the injury. . . . There is nothing . . . to show that he intended to abandon his employment, or that his presence on the gallery was for purposes other than those for which he may have rightfully gone there." (Bushing vs. Iowa Railway & Light Co., 226 N. W. 719.)



Conduits for control cable between large power plant and control building

SELECTING CONTROL CABLE

for Power Plant Equipment

By H. M. Friend
New York City

ONE has only to look at the extensive control-cable systems in modern power plants to realize the importance of this part of the equipment. The photograph on this page shows the control wiring conduit running between the control room and a large power station and gives a good idea of how extensive such a system is. Since the continuous operation of equipment depends in no small measure upon the reliability of the control system, it is of extreme importance that the latter be well designed and constructed.

A search for literature and specifications on control cable will reveal practically none devoted exclusively to this subject. The major engineering societies have quite comprehensive specifications covering insulated cable; but there is only one specification, excepting those of individual companies, that covers control cable. This is the Canadian Engineering Standards Association "Standard Specification for Control Cable for Electric Power Plant Equipment," No. C-21, 1927. While this specification covers the main points in the construction of control cable in a brief manner, it does not mention the inspection and testing of the cable, a matter vital to obtaining high-grade material. There are numerous details that cannot be covered in a specification.

Control cable may be divided, according to its outer covering, into three types: Flameproof, weatherproof, and lead-covered. Subdivisions of each of these types are single- and multiple-conductor.

Where control cables do not run in conduit a flameproof braid covering may be used. This may consist of either one or two soft-cotton braids impregnated with a flameproof paint and designated single- or double-flameproof. While this braid is not absolutely uninflammable, it will not support combustion, merely smoldering when exposed to a flame or a high temperature. If a more uninflammable covering is desired it may consist of either one or two asbestos braids. These types of covering should not be used where the cable is exposed to moisture.

The question of whether a lead sheath or a weatherproof braid covering should be used has been decided both ways. Some engineers specify lead-covered cable throughout the control system, while others prefer braid and use lead only where heavy moisture is encountered.

One of the largest power plants in the New York City area uses only lead-covered control cable, and one of the largest hydro-electric developments uses weatherproof braided cable almost entirely. The advantages claimed for the lead covering are that it is uninflammable, more durable, and better protects the conductors from moisture, rats and short circuits. In very damp places, it is universally agreed that the lead sheath is the most desirable.

The advantages claimed for weatherproof braid covering are that it is lighter, easier to install, and has a lower initial cost than lead-covered cable. Also, there is no danger, as in the lead sheath, of cracks caused by rough handling during installation, or, occasionally, due to crystallization of the sheath. Crystallization has been found in installations where the cable was shipped long distances by rail, and is attributed to excessive vibration in transit. This is a rare defect, and even the cable

manufacturers have had little experience with it. The chief engineer of a large company recently said that he had often heard of this defect, but only lately had seen a sample.

When lead-covered cable is shipped a long distance its ends should be firmly secured to the reel, and the reels should be lagged and blocked rigidly in the freight car to prevent shifting. Several layers of burlap wrapped tightly over the outer layers of the cable before the lagging is applied make a good covering to prevent injury to the lead sheath in case the lagging is damaged.

Soft annealed copper wire is used, the conductors being either solid or stranded. The latter are preferable because of their greater flexibility. Tinned copper prevents the sulphur in the rubber compound from attacking the wire. Some purchasers specify a cotton wrapping over the conductors, which is applied before the insulation. This facilitates stripping the insulation from the ends of the conductors when making connections. Some rubber compounds adhere tightly to the copper, and in such cases the cotton wrapping on the wire is quite an advantage when installation is being made.

Conductor sizes depend upon the current to be carried. Sizes most frequently used are No. 12, 9 and 7 B. & S., which are made up as in Table I.

Rubber compounds or Kerite is used for insulation. Varnished cambric has been used in a few cases. Rubber insulation is made from a 30 or a 40 per cent compound (percentage by weight) of highest grade new hevea rubber. Kerite is claimed to withstand high temperatures better and to age more slowly than rubber. While the composition of this compound is not made public, its appearance is that of a soft rubber compound, and its tensile strength is much less than that of the 30 per cent rubber insulation, commonly employed in making control cable.

Although control wiring forms a part of practically every piece of electrical equipment in a power plant or a substation, very little attention has been given to it in technical literature. It was to supply this lack of information that this and a future article was prepared. The different type of control cables; their construction and insulation; and color combinations for easily distinguishing the individual conductors are considered in this article. Inspecting and testing of control cables will be the subject of a second story.

While up to the present time specifications for rubber-insulated control cable have always required either a 30 or 40 per cent rubber compound or Kerite compound, an important change may soon develop. Rubber compounds have proved satisfactory for insulating wire except in respect to ageing. For a time the cable easily meets the specification requirements for physical and electrical properties, but after several years it will not pass these tests. The insulation becomes hard and brittle, with low tensile strength, and will crack, thereby losing its dielectric strength.

Rubber-insulating compounds consist of a mechanical mixture of rubber, inorganic mineral fillers, sufficient sulphur to make the rubber vulcanize properly, and waxy hydrocarbons to make the compound flow freely. And of these it is the rubber that ages. The popular belief that increasing the percentage of rubber increases the quality of the insulating compound appears to be erroneous. The Kerite compound was developed without rubber. However, as made it possesses some rubber, since it was found that this was needed to make the compound flow freely in the dies, but the quantity of rubber is kept to a minimum, and is not the basic ingredient in the compound.

During the last few years practically all of the manufacturers of high-grade rubber-insulated cable have developed special compounds having superior resistance qualities to ozone, heat and aging. While these compositions are kept secret, it appears that the percentage of rubber has been reduced below 30 per cent and that hydrocarbons are added, which give non-aging qualities superior to rubber.

One manufacturer who has conducted extensive tests on his different rubber compounds by the Greer aging test has found that the intermediate compound, containing approximately 23 per cent rubber and a large amount of hydrocarbons, has non-aging qualities superior to compounds containing higher percentages of rubber. This manufacturer now recommends this intermediate compound for control cable as superior to the usual 30 or 40 per cent rubber compound. However, he states that to supply this compound the usual specifications for 30 per cent rubber insulation would have to be changed, as the new insulation will not meet the physical and chemical requirements of such specifications.

Another manufacturer, who claims to make the highest grade 30 per cent rubber insulation, declares that his compound has superior non-aging qualities due to the use of the best of raw materials and special processes of manufacture. This company has also developed a new compound that is recommended for high-voltage work or where the cable is exposed to high temperatures, as in boiler rooms.

At the present time the question of the most suitable rubber compound for insulated wire has not been settled. The fact that leading cable companies have recently developed new compounds possessing resistance qualities to ozone, heat and aging superior to the 30 and 40 per cent rubber compound shows that there is a trend away from the old standard.

Purchasers who buy large quantities of control cable each year are in a position to satisfy themselves as to its qualities. However, the small and occasional purchaser will probably find it is best to buy from a company that has established a reputation for a high-grade product, and to act largely on the manufacturer's expert advice. Companies that buy on a price basis must answer the question of obtaining the cheapest product on the market, as ascertained by a number of competitive bids; or of limiting the bids to those companies whose products meet the requirements of the purchaser and accept the low-

TABLE I—SIZE AND STRANDING OF CONTROL-CABLE WIRES

Cond. Size B. & S.	No. of Strands	Each Strand: Size No. B. & S.	Each Strand: Diam., In.	Circ.Mil.	Approx. Outside Dia., In.
12	19	25	0.0179	6,088	0.0895
9	19	22	0.0254	12,198	0.1270
7	19	20	0.032	19,380	0.1600

est. As the voltage of control systems is 125 to 250, the thickness of insulation is generally $\frac{3}{64}$ in., although in a few large installations $\frac{1}{16}$ in. has been used. The former value is the thickness of insulation specified by the American Institute of Electrical Engineers for 600-volt service. As these insulated single conductors are tested in water at 3,000 volts and as they will not fail at a voltage of at least 7,000, applied between the conductors and a metal conduit against which the insulation is in contact, a large factor of safety exists.

The engineer has the choice of using single-conductor cable or, where a number of conductors can be grouped, of using multiple-conductor cable. The use of multiple-conductor cable is by far the most general. It requires less space and the cost of the cable and conduit system is lower. However, one of the largest hydro-electric developments in the East uses single-conductor cable in practically every control circuit. The advantages claimed are that a fault in one cable will be localized and will not spread to other conductors. In case of a failure it will be necessary to replace only the damaged conductor. Also, as the cost of the colored braids on the multiple-conductor cable is high, their omission on the single-conductor cable makes the total cost for single-conductor no higher than for the multiple-conductor system. This installation consists almost entirely of single-conductor cable, composed of 19, No. 25 B. & S. wires, insulated with $\frac{3}{64}$-in. 40 per cent rubber compound and covered with one rubber-faced tape and one black weatherproof braid.

Recent control cable installations quite different from the usual are those in two large stations in the Middle West. The customary conduit system is dispensed with and in place of it troughs are molded in the concrete structure. The cable, which is of special construction, is laid direct in these troughs. Varnished cambric is used for insulation, with a special metal-armored covering, somewhat similar to BX. The conductors consist of stranded untinned copper insulated with varnished cambric applied as tape, with petrolatum between the layers. Colored cotton braids are used to distinguish one conductor from another. The conductors are cabled together in concentric lay, with jute fillers to round out the cable, and over this one layer of rubber-faced tape is applied with an overlap. The outer covering consists of a lead sheath covered with a wrap of impregnated jute, over which is a special armor. The use of varnished cambric in this cable is quite unusual. It has certain advantages, although more expensive than rubber insulation. Varnished cambric will stand high temperatures better and does not age as rapidly as rubber.

TABLE II—TRACER THREAD COMBINATIONS USED IN MULTIPLE-CONDUCTOR CABLES

Conductor No.	
	Conductors in white braid:
1	White braid, no tracer threads
2	Red threads parallel
3	Black threads parallel
4	Green threads parallel
5	Red crossing red
6	Black crossing black
7	Green crossing green
8	Red crossing black
9	Red crossing green
10	Green crossing black
11	Green and black parallel
12	Red and black parallel
13	Red and green parallel
14	Green and black crossing red
15	Green and black crossing green
16	Green and black crossing black
17	Black and red crossing green
18	Black and red crossing red
19	Black and red crossing black
20	Green and red crossing green
21	Green and red crossing red
22	Green and red crossing black
	Conductors in black braid:
23	White threads parallel
24	Red threads parallel
25	White crossing white
26	Red crossing red
27	Green crossing red
28	White crossing green
29	White crossing red
30	White threads parallel red
	Conductors in red braid:
31	White threads parallel
32	Green threads parallel
33	Black threads parallel
34	White crossing white
35	Green crossing green
36	Black crossing black
37	White crossing green
38	White crossing black
39	Green crossing black
40	White parallel black

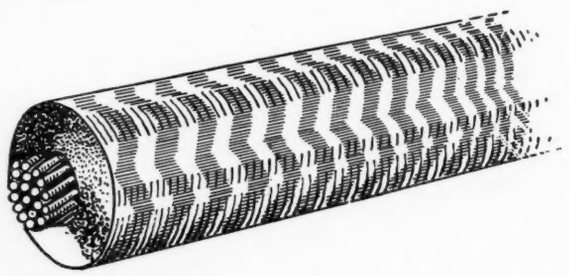
Each of the above colors is to consist of two threads. Blue is not used, because it is difficult to distinguish from green. Brown is not used because it is difficult to distinguish from black. Orange or yellow are not used because either is not distinctive when the braid is saturated with white wax. Purple is not a staple color.

TABLE III—COLOR COMBINATIONS FOR 27-CONDUCTOR CABLE

1—White	13—Red and black	22—Black, red and green
2—Black	14—Green and black	23—Red, yellow and green
3—Red	15—Orange and white	24—Red, white and pale blue
4—Yellow	16—Orange	25—White, orange and green
5—Green	17—Orange and green	26—Black, orange pale blue
6—Pale blue	18—Orange and black	27—Red, green and pale blue
7—White and red	19—Blue and red	
8—White and green	20—White, black and red	
9—Yellow and black	21—White, black and green	
10—Orange and blue		
11—Red and green		
12—Yellow and red		

No filler is used in any control cable. One rubber-faced tape over all, smooth side in.

Distinguishing colored braids are usually woven over the insulation of multiple-conductor control cable so that



Braid coloring woven in zig-zag strips around the conductors

the two ends of each conductor can be easily identified when making connections. If colored braids were not used it would be necessary to locate the two ends of each conductor by testing and attach numbered tags.

As the object of the colored braids is to definitely locate each wire, colors should be specified that can be easily distinguished, even by dim lights and after the braids have become soiled. Unfortunately, this feature has not been taken care of in many instances, poor colors often being selected. For single-conductor control cable the Canadian Engineering Standards Association specifies a paraffined white-cotton braid over the installation. However, the use of such a white braid is not common in this country.

When the cable contains two conductors, a good color combination is white for one and black for the other. If one conductor is grounded it should always be the black, as the color resemblance between black and ground makes it easy to remember. For a three-conductor cable, black, white and red is a good combination, and for four-conductors, green can be added, with yellow for five conductors. Blue, brown, orange and purple should not be used, because the first three are not easily distinguished from the previously mentioned colors, and purple is not a staple shade.

As the number of easily distinguished colors is limited.

for cables containing a larger number of conductors there are several color schemes in use. One cable-manufacturing company has a specification covering up to 40 conductors, using four colors, white, black, red and green in various combinations of parallel and crossing threads, first against a white braid, then against a black braid, and lastly against a red braid. The detailed list of these conductors is given in Table II.

One large public utility has a specification covering a cable up to 27 conductors. Braids over each conductor must be at least 4 ends, each consisting of not less than No. 40 two-ply cotton. Seven colors are used in various combinations, Table III. Where two or three colors are used in one braid they are applied in the form of spiral stripes, except 7, 9 and 13, which are checker fashion.

The Canadian Engineering Standards Association's specification covers cables from 1 to 15 conductors, with the identification markings, Table IV. It uses single

TABLE IV—COLOR COMBINATION USED BY CANADIAN ENGINEERING STANDARDS ASSOCIATION

1—White	6—White and black	11—Black and green
2—Black	7—White and red	12—Black and yellow
3—Red	8—White and green	13—Red and green
4—Green	9—White and yellow	14—Red and yellow
5—Yellow	10—Black and red	15—Green and yellow

colors for conductors 1 to 5, after which two colors are woven in transverse zig-zag strips, each strip being of the same width as in the figure.

As some color combinations are quite complicated, it is difficult, under the same specifications, to obtain from different manufacturers cable whose braids are identical; therefore, the simplest combinations should be used. The specification of the Canadian Engineering Standards Association meets this requirement, as any manufacturer can interpret its instructions without difficulty and produce identical colored braids. This specification, however, has the disadvantage that it covers only 15 conductors, where as many as 37 are sometimes required in a cable.

While colored braids are generally used on multiple-conductor cable, the cost of these braids is high; therefore any practical means of dispensing with them would reduce the cost of the cable. It is possible to omit the braids on the individual conductors and after installation to test the conductors and tag their ends. Another method is to have a ridge in the insulation on one conductor made by a nick in the die of the insulating machine and to locate each conductor by counting clockwise from this conductor.

It is quite important that the purchaser adapt a standard color combination and specify it on all orders for control cable. Otherwise, if orders are placed with different manufacturers, he will obtain cable with their standard color arrangements, which are different with each manufacturer. The writer has seen this happen in one large power plant with the result that some control circuits which started out from the switchboard with certain colors ended at the equipment with a different color. This was caused by splicing together two lengths of cable coming from different manufacturers.

It is also desirable to have the inspector who makes the final check of the cable at the manufacturer's plant list on the test sheet the colors used on each conductor. This gives a valuable source of reference in case anyone questions what colors were furnished on the individual braids. Some engineers provide one or more spare conductors in multiple-conductor cables, to be used for added circuits or in the case of the failure of one conductor.

Primary-Resistance Vs. Compensator-Type Starters

By M. A. Walker

AUTO-TRANSFORMERS have been used so generally for starting squirrel-cage induction motors that they are frequently accepted without giving consideration to the possibility of using primary-resistance-type starters. It is true that with a given load an induction motor will take less current from the line when starting is done by an auto-transformer than when a primary resistor is used. However, this does not tell the whole story as to what happens in the power system when starting a motor.

Because of the way the conventional type of starting compensator using auto-transformers is built, it is necessary to apply sufficient voltage to the motor to start it under the worst load conditions. Where the starting load is constant, a tap may be selected on the auto-transformer that will give a minimum voltage and current for the initial load. If the motor is sometimes started under light load and at others under heavy, the compensator must be adjusted to allow the motor to start under the heavy loads. This means that the same voltage is applied to start the motor under light loads as is used for heavy loads.

With one type of resistance starter the current can be controlled from practically zero up to the locked-rotor current of the motor. With such a starter the voltage is applied to the motor gradually and the current builds up in the system in a similar manner. Even though the motor may take a greater current from the line, when using a resistance than that required with a compensator, the larger current may cause less disturbance to the line voltage. With the resistance-type starter the power system is given time to adjust itself to the load conditions, where with the compensator the load is applied suddenly.

Another objection to the compensator is that after the motor has been accelerated on the reduced-voltage tap, full voltage is applied to the motor suddenly. In the transition from reduced to full voltage the motor is disconnected from the line, and this may produce a condition in the motor that will cause the full-voltage peak current to exceed the reduced-voltage peak.

Even when starting the motor with one-step resistance, the peak current at full voltage is small. Starting with a compensator gives practically a constant reduced voltage at the motor terminals. The maximum voltage drop across the resistance occurs with maximum current. As the current is decreased the voltage drop across the resistance decreases. This means that when a resistance is connected in series with a motor for starting, the voltage will be increased at the motor terminals as it comes up to speed and the starting current decreases. Under such conditions the motor will come up to more nearly full speed than when the reduced voltage is held constant, as with a compensator. Then when applying full voltage after starting with one step of resistance, the resistance can be short-circuited and the motor not disconnected from the line as with the compensator. For these reasons the second current peak is low when starting with a one-step resistor.

The foregoing should not be taken to mean that all starting of squirrel-cage induction motors should be done by resistors. It does show, however, that the resistor starter has desirable qualities that are frequently overlooked.

Results of European Research in the Aging of Turbine Oils

By J. D. Lloyd

IT IS DESIRABLE to keep a turbine oil in use as long as possible, but not so long that the proper lubricating film cannot be maintained, since such a condition would endanger the equipment. Consequently, both maintenance and operating men will be interested in the results of some experimental work on the aging of turbine oils in use, reported upon not so long ago by European investigators.

In the April 20, 1928, issue of *Petroleum,* Baader tells of two experiments that were carried out in two similar 14,000-kw. turbines alike in construction and size, with two oils made from the same distillate, one of them refined by the usual method with sulphuric acid and bleaching earth and the other by a new process. In the moisture test by the Spratz method a distinction was made between free- and bound-water content. The normally refined oil deposited a gray, powdery sludge in all oil passages, and the experiment had to be broken off after only 8,494 hours' running. The other oil, after more than 16,000 hours' running, had shown no sign of excessive aging. The powdery deposit proved to be a mixture of organo-metallic compounds, of which tin formed 57.10 per cent. The ash content was raised by this sludge, but otherwise increased very slowly and could not be taken as an indication of aging. The oil that aged more quickly formed constituents that were oil-soluble, but precipitable with normal benzine, and water-soluble compounds that reacted acid to methyl orange.

According to Baader, changes in emulsibility, solidifying point, specific gravity, viscosity, flash point and oiliness give at most only secondary indications as to aging. The primary indications are: Acid number, saponification number, tar number and sulphuric-acid reaction. In the test runs these numbers rose steadily for both oils, but about three times as rapidly for the normal refinate as for the special. Baader concluded that the acid number represents only a portion of the products of aging and must be complemented by the tar number and the saponification number, especially the latter.

Experiments in artificial aging of turbine oils were carried out by Schmidt (*Z. angew. Chem.,* Nov. 3, 1928) by oxidizing the oils with and without catalysts, at different temperatures; with and without, oxygen bubbled through, both dry and in the presence of water. A temperature of 100 deg. C. was found to be better than 120 deg. C. for aging tests, because small differences in experimental conditions, such as local overheating, had an exaggerated effect at the higher temperatures; furthermore 100 deg. C. is closer to the temperature of the oil in use.

Schmidt found that changes in density and viscosity with aging were not significant. Emulsibility tests, even though conducted with every care to keep conditions uniform, gave variable results with no apparent relation to the deterioration of the oil. Merely determining the acid number of an oxidized oil gives a measure of its age, although it says nothing about the specially harmful insoluble sludge. By introducing water into the oxidation vessel simultaneously with metal, it can be seen that the presence of the water slows down the process of aging. Aging with catalyst without introducing oxygen gives the same picture qualitatively as is obtained with oxygen; but the aging process is too slow for a practical method. Working in the cold, no measurable change takes place in the space of 120 hours.

According to Schmidt, curves showing the catalytic effect of iron, tin, brass, white metal and copper in aging demonstrate clearly that some oils are more "metal-sensitive" than others toward any given metal. Copper oxide is well suited for aging tests. It avoids the difficulties involved in the use of pure copper from its surface activity, a fact which renders it almost impossible to obtain reproducible results with it.

The following method using oxidized sheet copper gives excellent results, says Schmidt, for acid number and tar and asphalt percentages in aged oils: 125 grams of oil is treated for 70 hr. in a 250-300 cc. Erlenmeyer flask immersed in a level. A piece of oxidized sheet copper 4x5 cm. and about 0.5 mm. thick, rolled almost into a cylinder, is placed in the oil. Dry pure oxygen is passed through the oil continuously by means of two tubes in the stopper, at the rate of two bubbles per second. At the end of 70 hr. determinations of acid number and per cent of tar and sludge are made.

Testing Oil "Wearability"

Walther, in the May 5, 1929, issue of *Erdöl u. Teer* proposes a new method for testing the "wearability" of turbine, transformer and similar oils, claiming that the use of 96 per cent sulphuric acid for testing such refined oils is of very doubtful value in view of the fact that it indicates the presence of both the harmful substances and the useful ones, that is, the unsaturates, which act as protective compounds and reduce the tendency of the oil to oxidize; and the other labile compounds, which greatly accelerate the speed at which oxygen is taken up.

For used oils the per cent soluble in 96 per cent sulphuric acid tells nothing unless the solubility of the oil when new is known; and even if this is known, the solubility cannot be determined with an accuracy within 0.5 per cent. It is well known that sulphuric acid of different concentrations acts differently upon the various groups of compounds contained in oil; and upon this fact are based the analytical methods of Risenfeld and Bandte, Kattwinkel and others.

According to Walther, in testing turbine oils, etc., for the presence of compounds that greatly accelerate the speed at which oxygen is taken up, *a dilute acid should be used.*

The oil is diluted with benzine to permit the acid layer to settle out quickly. Five cc. of the oil is measured into a test tube or stoppered cylinder of about 15 mm. inside diameter, dissolved in 5 cc. of benzine, and 5 cc. of 50 per cent sulphuric acid is added. The tube is shaken energetically for half a minute and then allowed to stand. When separation is complete, the color of the acid and oil and, in some cases, the change in color of the oil layer, are observed.

Walther states that from the observation of a number of tests thus performed it seemed probable that when the acid is added to an aged oil the oxidation products present are separated into two groups: The acids are dissolved in the sulphuric-acid layer, coloring it darker, and the asphaltic substances, if any are present, are thrown out of the oil, but form an intermediate layer between the oil and the acid, and allow some change of color in the original oil. For the same kind of oil, these changes are roughly proportional to the degree of aging.

A splendid piece of architecture: "Chade's" new Buenos Aires power house, a massive building of reinforced concrete, with windows of great height and set close together, giving the effect of a colonnade.

Buenos Aires Builds for BEAUTY *as well as* POWER

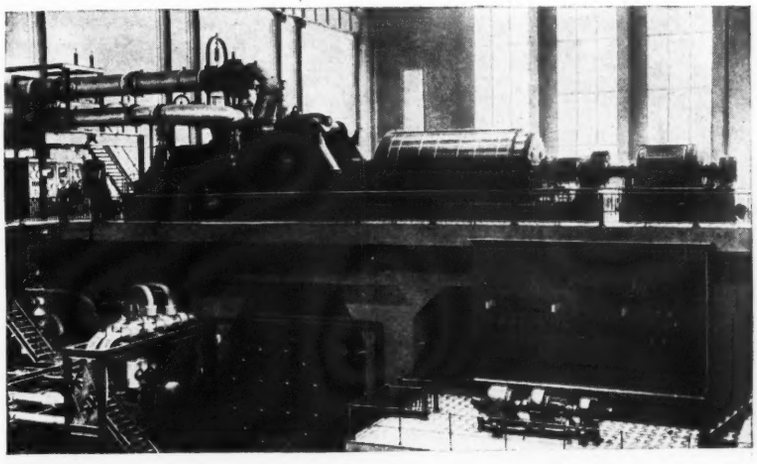
ON THE waterfront of Buenos Aires, on land that was lifted out of the river bed to be added to the area of the city, there has been built in the last two years a central generating station that is planned for an ultimate capacity of a million horsepower. This is the new station of Cia. Hispano-Americana de Electricidad, popularly known, from its initials, as "Chade," the company that furnishes the chief supply of electric energy for Buenos Aires and vicinity.

The growth in population and the expansion of industry and of business in this queen city of South America have been so rapid in recent years that existing power plants have been unable to cope with the present and immediate future demands for electric energy. Laying its plans, therefore, with a view to future requirements, the Chade adopted a building program three years ago that culminated in the dedication of its new generating plant on last July 5.

It is on a plot of 30 acres of reclaimed land taken from the bottom of the River Plata in the course of dredging operations. The situation gives access to ocean ships, which bring coal directly to the wharfs of the power house, and provides for an unlimited supply of condenser water. It is next to the most thickly populated section of the federal capital.

The construction of a coal wharf, along with the work of reclamation, was begun in November, 1926, and was finished in the spring of 1928. A special channel leads to this wharf, branching from the main ship channel. Work on the power house was started in January, 1927, and in December of that year the boilers were installed. Erection of the two turbine-generators and the installation of the fuel-handling machinery began in January, 1928. At the close of that year the first turbine-generator was tried out and immediately put into commercial service, followed shortly afterwards by the other unit. They are 52,500-kw. machines built in the Schenectady Works of the General Electric Company. At that time they were the largest that had ever been shipped overseas. Provision has been made for future expansion that will allow a total of twelve turbine-generators under a single roof in a room 800 ft. long.

One of the tandem-compound turbine-generators



Sargent & Lundy of Chicago are consulting engineers for the project.

The boiler room, which measures about 176 by 200 ft. and is 110 ft. high, with ample space for further extension, has at present eight Babcock & Wilcox boilers utilizing pulverized coal. The most modern methods of coal handling have been adopted. Imported coal is brought to the company's wharf in ocean steamers and unloaded at the rate of 100 to 150 tons an hour. Two gantry cranes run along the dock in line with the ship's hatchways, and buckets taking 6 cubic yards at a time dip up the coal and carry it to a belt conveyor, which dumps it at one of four deposit stations, each with a capacity of 40,000 tons. The coal piles are surrounded by lawns and trees.

The coal is lifted from the deposit stations by other conveyors and carried to the pulverizing plant, a building of about 150 by 50 ft. and 75 ft. high. Here the coal is dumped into five hoppers, from which it passes over weighing scales and through driers to the pulverizing mills, each having a capacity of 15 tons an hour. The pulverized coal is conveyed by compressed air into the boiler room and there distributed to the boilers.

Each steam turbine-generator set has a capacity of 52,500 kw. The turbines are tandem compound, taking steam at 550 lb. gage, 750 deg. F. at the throttle. After passing through the high-pressure unit the steam is sent back to the boilers and reheated to 750 deg., discharging finally at a vacuum corresponding to cooling water at 17 deg. C. Direct connected to the turbine shaft are the main generator, an auxiliary house service generator and their two exciters. The main generator is rated 50,000 kw., 3 phase, 50 cycles, 1,500 r.p.m., 92 per cent power factor, 54,350 kva., 13,200 volts. The auxiliary generator for house service is rated 2,500 kw., 3 phase, 50 cycles, 80 per cent power factor, 3,125 kva., 2,300 volts. From the low-pressure units the steam discharges into Worthington condensers beneath the turbines. Boiler-feed pumps, hot-well pumps, drip pumps, and circulating pumps of the Worthington Company and other auxiliary station apparatus are driven by General Electric motors.

A Symbol of Power

NEXT WEEK, Nov. 26, an entire number of *Power* will be devoted to the power plant and services of the New Yorker, newest and largest hotel in New York City.

¶ Here under one roof are to be found pulverized coal, steam and Diesel engines, heating, ventilation, air conditioning, steam and hot-water supply, electrical applications, elevators and systems of communication.

¶ The inter-relation of all of these services will be shown from the operating and heat-balance standpoints.

A Personal Glimpse of Herbert Ackroyd Stuart

By John Sturgess

"THE Hornsby-Ackroyd engine antedated the Diesel as a self-ignition engine, but Herbert Ackroyd Stuart never received his deserved recognition",—I recently read in *Power*, and the author of that statement is quite right. A personal reminiscence of Ackroyd Stuart is not recognition in the sense implied, but may be of possible interest, as coming from one who worked with him on his original engine.

It was known as the Ackroyd Stuart engine then, for it was not until some two years later that he tied up with the old English engineering firm of Hornsby & Son, of Grantham. The original engine was built under Stuart's direction at the engineering works of George Wailes & Company, Euston Road, London, where the writer was an apprentice. This was about 1891. The first engine, which was about 9x18 in. bore and stroke, had a striking resemblence to the later designs, except that to hurry matters up the main frame was cast before many of the details of valve gear, pumps, etc., were designed. A patchy appearance resulted from their being stuck on with "chipping pieces" in various places. The same design of hot cylinder extension, or hot bulb, and the same type of valve gear was used on the first engine as later.

It was heroic work getting the bulb hot enough to start, and many near-conflagrations resulted, also many backfires coming from no one knew where. Mr. Stuart was a tall, slim man, with a beautiful pointed waxed moustache, but one day he was stooping over the engine and one of the unexpected backfires occurred, which blew off exactly 50 per cent of the moustache. The right half was missing.

In the main, the engine ran very well, and created considerable interest, but he was unable to induce the George Wailes Company to exploit it, though they could have well done so, having the resources and the equipment. So he took it to Hornsby's, and it subsequently became known as the Hornsby-Ackroyd.

I might mention another engine that was built in the same shops at about the same time. This was a gas engine without any valves, a sort of forerunner of our present sleeve-valve types. The piston was given a rotative as well as a reciprocating motion, so that a scratch line made by a point on the piston described a figure 8 on the cylinder wall. This permitted openings in the cylinder wall and piston to give all the events. The rotative motion of the piston was produced by bevel gears, one keyed to the crankpin alongside the big end of the connecting rod, and the mate keyed to a tube attached to the piston and fitting over the circular section of the rod. The wrist pin was a ball, permitting the rotation of the piston.

This engine worked very well, and looked neat compared to other engines of the day, because there was no valve gear of any kind and no afterthoughts stuck on around, with chipping pieces. As far as I know it died a natural death, without pain. The inventor of this also experimented with air-cooling, and built a little ribbed engine to see what would happen. It was about 2x3 in. We all thought it looked very pretty as it gradually got red hot, but it suddenly emulated the one-horse shay, and "quit" all over with a very disagreeable noise.

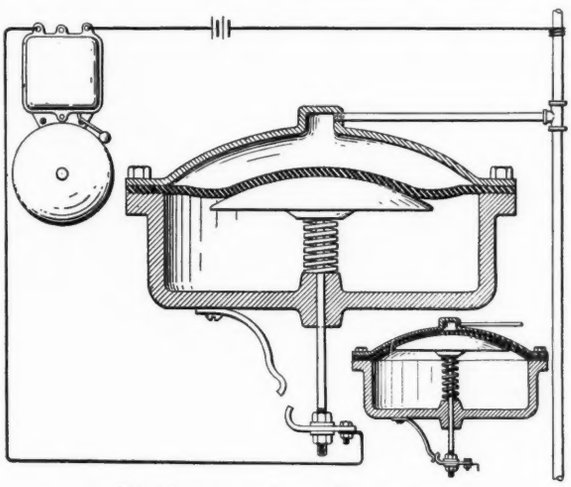
Right Out of the Plant

Low Air-Pressure Alarm for Temperature Control System

IN OUR plant a small air compressor is used to automatically maintain 15 lb. of air pressure on our system of temperature control, its range being between 14 and 16 lb. Occasionally the compressor fails to start again after the pressure falls below 14 lb., with the result that all radiator valves in the building open wide and the building becomes overheated in a few minutes.

As the plant attendant or engineer has other duties to attend to, often he does not notice this condition before someone from the overheated rooms calls his attention to it.

To obviate this trouble we made an alarm outfit from material around the plant, consisting of an old diaphragm valve, two dry batteries and a bell. Referring to the



Diaphragm valve with contacts

sketch, a tee was put in the $\frac{1}{8}$-in. air pipe and the diaphragm valve connected. From the batteries a wire was grounded to the air pipe, making a continuous circuit to the contact. From the other side of the battery a wire was run to the bell and from the bell to the movable contact, which was insulated from the valve rod by the two mica strips.

The larger view shows the diaphragm inflated and the circuit broken, and the smaller one the diaphragm collapsed and the contact closed. NELS HILSEN.

Duluth, Minn.

Is Caustic Embrittlement Real?

EXTENSIVE interest, investigation and discussion have of late been focused on the cause of "caustic embrittlement" of boiler steel. This trouble seems to be manifest principally along a line of rivets, such as in the steam drum of a water-tube boiler, where chrystalline cracks appear. Uncalled-for importance seems to have been attached to this phenomenon as being the direct cause of failures. Perhaps the quality of workmanship in building the drum may be the underlying cause, or at least partly so.

In a recent issue of *The Metallurgist* a writer states that, "The suggestion implied in the term 'caustic brittlement' that the action of caustic soda can render steel brittle is, of course, quite unsound. Even where steel has, probably under the action of caustic soda, developed a system of deep intercrystalline cracks, near the rivet holes of a boiler seam, the steel itself is not rendered brittle thereby. If a piece in which cracks are present is drawn out in a tensile testing machine there is no tendency for the cracks to spread further along the crystal junctions; each crack behaves exactly as would a similar incision produced by mechanical means, and the steel draws out in a perfectly ductile manner."

As a specimen for our study, suppose we take into consideration a boiler steaming under normal load conditions with good feed water. The circulation is regular and uniform and follows a definite path directed by the design of the boiler. No violent surges are occurring within the boiler, as indicated by a steady level of the water in the gage glass. In case the water carries high concentrations of soluble salts, particularly caustic soda together with varying quantities of oil, which is in evidence in many industrial plant boilers, the density of the water is increased in a short time to a degree at which it will be in a violent turbulent condition, this condition, in some cases, causing the boiler to surge violently.

The agitation of the water in the gage glass indicates to a limited extent what is occurring within the boiler, and is prevalent in some types of water-tube boilers. Let us take for example the four-drum bent-tube type and consider the character and nature of the cracks in this class. This boiler has the front and rear drums at the same level and the center drum about a foot higher. The water column is usually attached to the center drum, from the fact that it is at the higher level and the least disturbance occurs in it. With the water level between the second and third gages before steam is developed, it will be almost to the top of the glass when the boiler is put into service, at which time the front drum will be full of water, and the level in the rear drum will be 7 or 8 in. high, or close to the bottom. At certain ratings the level may drop to, or below, the upper ends of the tubes in the rear bank.

Following the path of the steam generated in the front bank, it rises to the top of the drum, where the circulation is retarded somewhat, because this drum is practically full of water, limiting its liberating surface to the steam-circulating tube area, which is insufficient to relieve it of all the steam it receives. The result is a partial reversing of the flow or dividing the steam in the lower end of the front tubes, with a portion of it being driven into the mud drum, which becomes partly filled with steam. With the circulation being downward in the center bank and owing to the presence of steam in the mud drum, the water tends to fall like rapids. This falling results in a shock caused by the impact of the water in the tubes against that in the drum, which receives full effect of the shock.

In one certain case on record that showed signs of what was pronounced a caustic embrittlement, on thoroughly scrutinizing the effect, a permanent distortion of the shell was indicated. This distortion, being found

in the vicinity of the known greatest effect of the impacts, would seem to be sufficient evidence that it was caused by them. At the height of the breathing action, the shell split and rivet heads jumped off. No evidence of caustic embrittlement was found in any of the other parts of the boiler, which were as susceptible to its conditions of development as the point of rupture. Rivet burning previous to driving could not be detected. The permanent set of the metal showed that the construction was adequate on one side of the center of moment, while some degree of motion freedom existed on the other side.

Use of the term "embrittlement" is, I think, misleading. Boiler experts find difficulty in accepting the matter as a whole, since something like general steel embrittleness seems to be implied, which they are well aware does not exist in steel.

Professors Kommer and Moore conducted a series of tests at the University of Illinois that threw some valuable light upon the subject of the behavior of metals subjected to reversed stresses, with respect to crystalline and intercrystalline cracks occurring in these metals, also effects of poor surface finish. The following points may be of interest:

"The endurance limits of ferrous metals could be predicted with fair accuracy by the temperature rise under reversed stresses applied for a few minutes, this relation being explicable in view of the intercrystalline cracks and intercrystalline slippage under repeated stress shown by the microscope.

"To show the effect of change of form, the following was pertinent: Abrupt change of form of specimens subjected to repeated stress greatly lowered their resistance.

"For the metals tested under reversed stress a well-defined critical stress, called the endurance stress, was observed.

"Poor surface finish on specimens subjected to reversed stress was a source of weakness, probably due to the formation of cracks by localized stress at the bottom of the scratches or tool marks.

"A better term for the phenomenon known as fatigue of a metal under repeated stress is progressive failure, the most probable explanation being that such failure is a progressive spread of microscopic fractures from a very small area of high localized stress due to a groove, scratch or crack."

Next in importance to the quality of the material employed in boiler making is the quality of the workmanship. There are a number of reasons why code boilers are not invariably constructed as well as they could be, one of which is the personal equation involved in the inspection made during construction. It is customary to locate one inspector in each shop, where he, having remained for a considerable length of time, is frequently but not without exception inclined to become localized to the plans of that particular shop. As these men are also inspectors for insurance companies, they cannot devote the whole of their time to inspection work within the shop, resulting in numbers of operations being executed in their absence.

A highly skilled inspector is necessary to detect poor workmanship in a finished boiler. Not infrequently are plate failures discovered in the butt straps, as every boiler maker knows. The last few inches of plate on both sides of the butting edge are not held securely by the bending rolls, and therefore maintain a tangent position in relation to the cylindrical section of the shell. Assembly of the butt straps and shell is often executed, and nothing else done to form a perfect circle of this portion of the shell, riveting and hammering being resorted to. The proper method is to form the shell and butt straps under hydraulic press dies previous to rolling. When this method is not followed, not only are high stresses developed from imperfect circle of the shell, but any impact strains will result in deflection of the structure and possible failure.

Untrue head circumferences to the shell plate, caused by improper lay-out and fitting-up, is commonly treated with sledging, which is detrimental to the material. The laying out of joints in such parts as water legs is not necessary when they can be fitted up while under heat to facilitate a metal-to-metal fit. Boiler leaks that cannot be checked without excessive calking are the products of poor workmanship, which will be discovered only after the boiler leaves the shop. Many such defects are entirely concealed, and not infrequently are they of serious character.

L. M. JORDAN.

Donalsonville, Ga.

Complete System for Feeding Boiler Compound

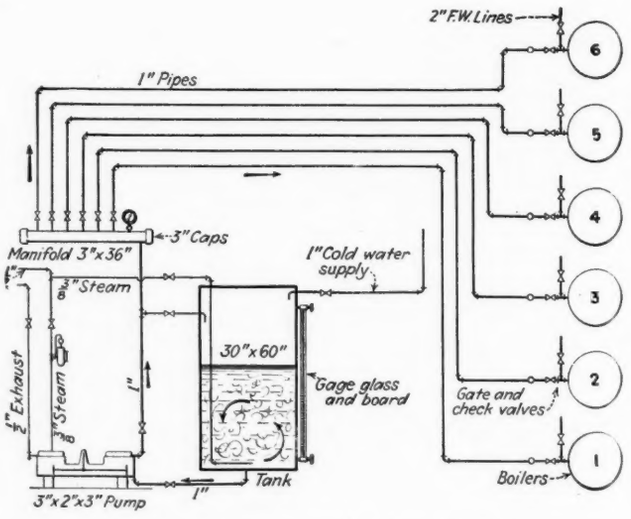
IN A recent issue of *Power* a reader wanted to know a good method of feeding compound to boilers.

The accompanying sketch shows a system used in a power plant containing six boilers. It is somewhat expensive to install for the purpose involved, but gives good results—and results are what count.

This system consists of a 30x60-in. tank with gage glass graduated in inches. A 3x2x3-in. duplex pump, a 3x36-in. manifold made of 3-in. pipe, capped at each end (the 1-in. nipples welded on) and the necessary pipe, valves, fittings, etc.

At this plant a sample of water is taken from each boiler every 24 hr. and analyzed to determine the amount of compound needed in each boiler.

Powdered compound is used. When the amount needed for each boiler has been determined from the analysis of the water, it is weighed out. For instance, if No. 1 boiler requires 7 lb., No. 2, 10 lb., etc., say a total for the six boilers of 45 lb., 45 in. of water is let into the tank. The water is warmed and agitated with steam



Arrangement of system for feeding boiler compound

from the ⅜-in. line, running down in the tank to near the bottom and directed so as to give the water a whirling motion. The compound is then poured into the water, and when thoroughly dissolved, the required number of inches corresponding to the number of pounds is pumped into each boiler.

When the tank has been emptied of compound it is filled about half full of fresh water and warmed with the steam, and enough is pumped through each line to flush all the compound out.

B. E. SMITHERS.

Memphis, Tenn.

The Basic Education of the Engineer

BEING well acquainted with both American and European literature, I should like to add some remarks regarding the article "The Basic Education of the Engineer" in *Power* for Oct. 15, 1929. The writer seems to think that the average European engineer is able to read any and every textbook published in Europe. This is far from being true. European textbooks are usually written by specialists for specialists, and so can be read by specialists only. A great many of our authors are so exclusively occupied with their fields that they have long forgotten the difficulties which they themselves had in the beginning when penetrating into them.

I have found that, on the contrary, most American textbooks give excellent introductions into the fields they deal with, and I think they are the better for it. A busy engineer cannot devote hours or days just to revamping, from half a dozen books, theories that he may not have wanted for years and which, consequently, have been forgotten in the meantime. The scientific and theoretical side of a problem should not be avoided, but it should be made clear. A book on a mechanical subject cannot, of course, contain a complete treatise on fundamentals, but it should be expected to clearly and unmistakably explain such things as the average engineer may be unfamiliar with. In European literature, I have sometimes experienced an utter lack regarding books of this kind, and have often found American books on the corresponding subjects to be the very things I wanted.

I know of many engineers who have learned quite a lot on mathematics, physics, etc., but who are unable to apply these fundamentals in daily practice and consequently depend on rules-of-thumb. What did they learn their theories for? Theory that is not applied is worse than no theory at all; it means waste of time and energy.

Many European books containing valuable information are not read by the majority of engineers because of a certain "highbrowism" on the part of their authors. Nothing would, in my opinion, be more incorreet than to believe that the European technical literature is readily understandable to the average engineer, and it would be a pity if the character of the American textbooks were changed. Especially, the foreign reader feels very thankful if the author "begins with words of one syllable," and if some explanations are really unnecessary for some readers, they will certainly not do them any harm. As a matter of fact, American books are being read more and more in England and on the Continent.

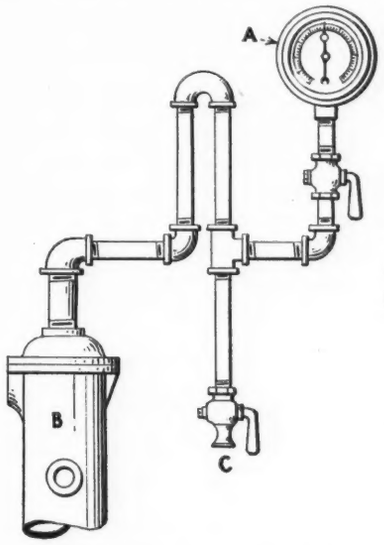
What is most important in engineering literature, is not the amount of available theory in general, but the amount of readily utilizable "matter-of-fact" theory.

MAX WÜLFINGHOFF.

Vegesack, Bremen, Germany.

Steam Gage Connection to Prevent Clogging

THE accompanying illustration shows an unusual way of connecting a steam gage. It has some points of advantage over the usual method, particularly where the water conditions are bad and where the pipe tends to seal or clog up. It is almost impossible for sediment or



Gage connection designed to obviate clogging

scale to be blown into the horizontal or vertical pipe connecting the steam gage when the cock is opened, as it is a straight blow through. The piece of pipe or drop leg between the tee and the cock serves as a trap for sediment and scale.

JAMES E. NOBLE.

Uffington, Ont.

Why the Polarity of Exciter Becomes Reversed

A TROUBLE sometimes encountered when running alternating-current generators occurs through the exciter reversing its polarity. This trouble is most frequent where the exciter armature and field cores are laminated and the generator field cores are solid.

In these cases the current in the exciter armature will die down more quickly than the current in the generator field circuit. This may be the cause of a reverse current flowing through the exciter armature, which may demagnetize or reverse the polarity of its field. This usually happens when the main breaker comes out and the exciter field is quickly opened to prevent an undue voltage rise on the generator. In these cases the inductive discharge from the generator field may reverse the direction of current flow through the exciter armature, and demagnetize or reverse the polarity of its field. If, before opening the exciter field switch, the resistance in the field is quickly cut down, the possibility of this trouble will be greatly reduced.

Making rapid changes to the exciter field is at all times inadvisable. When an exciter reverses its polarity, the British Engine and Boiler Insurance Company recommends the following method of restoring the polarity: Run the set up, magnetize the main field and rapidly break the exciter field circuit. Running the set up and putting in the field resistance at a rapid rate will often reverse the polarity of the field.

E. W. WILSON.

Brighton, England.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Tractor-Mounted Swing Crane for Industrial Uses

COMBINING mobility and power for lifting and swinging loads in crane service, with tractive power for haulage, the swing crane illustrated, brought out by Frederic H. Poor, Inc., 50 Church St., New York, has been designed to meet the demand in the industrial field for a small locomotive crane of general utility.

The unit, which is designated the Loadmaster, is "adaptable" to a variety of work around a power or industrial plant and to the setting of poles in transmission lines, handling piles, unloading cars and similar work.

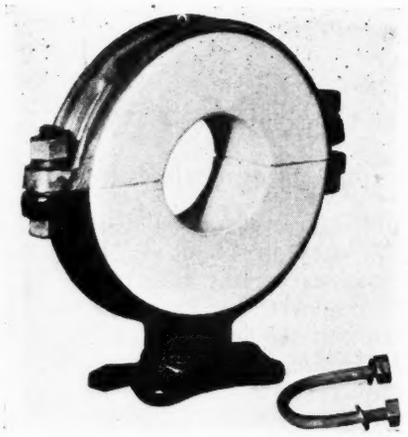
Tractor-mounted crane combines mobility and power for lifting and swinging loads in crane service with power for haulage

The crane structure is superimposed directly upon a tractor to which it is attached at the rear to the main axle housing and at the front over the axle. This construction gives a unit mounting for the engine, crane mechanism, mast and boom. One of the important features of the unit is the ability to swing the boom and load without maneuvering the tractor. The bull wheel for swinging the boom is power-driven and is equipped with a brake so that the boom may be set at any angle over the side or front of the tractor.

The hoisting drum is directly connected to the self locking worm gear, which, when the drum is not in motion, holds the load in suspension without the use of an added friction brake on the hoist line. Hoisting speed of the load may be varied up to a maximum of 38 ft. per minute.

When fitted with a standard 10-ft. boom the unit has a maximum lifting height of 12 ft. 4 in. under the hook, and with the boom lowered it has a maximum outreach of 10 ft. from the center of the mast in any direction. It has a width over the wheels of 65 in., a wheelbase of 78 in. and an over-all length of 10 ft., not including the boom. As an indication of its mobility, one machine is said to have traveled a total of sixteen miles and given crane service at six or seven points in the course of an eight-hour day. All controls are grouped at the rear, within easy reach of the operator.

The crane mechanism is especially designed for, and mounted on, a standard McCormick-Deering industrial tractor. The rear wheels are fitted with 40 x 10-in. solid rubber tires, and the front wheels are mounted on 29 x 5-in. solid rubber tires. Standard equipment includes: foot and parking brakes, foot accelerator, side "power-take-off," factory-sealed governor, replaceable engine cylinders, ball-bearing crankshaft, high-tension magneto with impulse starter and drawbar plate for automatic hook. The capacity of the unit is 3,000 lb., and the total weight 11,000 pounds.



Support with porcelain insulator

Clamp Insulator Support

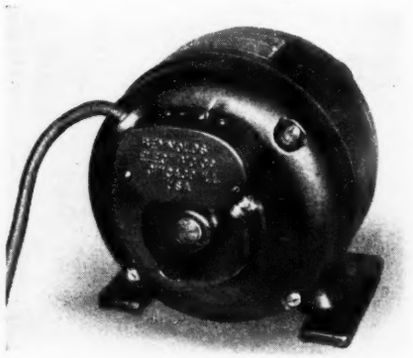
A NEW line of clamp insulator cable supports for either flat or pipe mounting, by means of U-bolts, is announced by the Champion Switch Company, Kenova, W. Va.

The white glaze porcelains are interchangeable, the supporting bases are malleable iron, and the top clamps are of alloy metal. The mechanical strength is high and the porcelain is designed for installations of wide temperature variations.

Motor With Built-In Switch

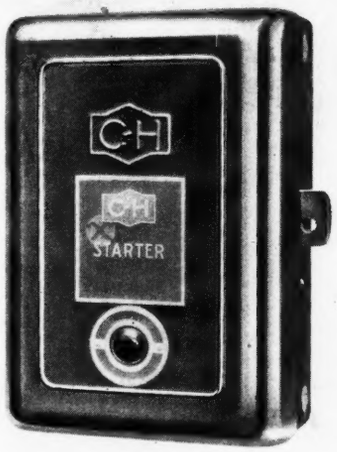
A MOTOR fitted with a built-in switch which facilitates easy starting and stopping has been introduced by the Reynolds Electric Com-

Motor has end terminal block and built-in switch



pany, 2650 West Congress St., Chicago, Ill. This feature, it is stated, eliminates the necessity of plugging in the current connection.

The motor is practically inclosed, but is adequately ventilated with a free circulation of air. The temperature rise is well under 40 deg. C. Some of the important features are a frame of machined cast iron; stator of punchings pressed together under heavy pressure and riveted; rotor of indestructible squirrel-cage type with copper end rings electrically welded to copper bars; and windings of cotton-covered enameled copper wire, inserted in insulated slots and held in place by heavy wedges. All connections are made to a terminal block located inside the motor but having the terminal screws readily accessible by removing a plate. The bearings are oversize and made of a special cast bronze-bearing material.



Counter e.m.f. automatic starter

Automatic Starter for Direct-Current Motors

THE counter e.m.f. type automatic starter for small direct-current motors illustrated incorporates a number of important features such as: small size, reduced-voltage starting, thermal overload protection, low-voltage protection and renewable silver contacts. It is rated up to 2 hp., 115 or 230 volts. Each starter is supplied with a separate push-button master switch providing three-wire remote control. Two-wire remote control can be furnished if desired.

The starters consist of a main-line contactor, an accelerating contactor, an armature resistor, and the thermal overload relays. On depressing the "start" button of the master switch, the main line contactor connects the motor to the line through the armature resistor. As the motor accelerates to the proper point, the counter e.m.f. of the motor armature closes the accelerating contactor, which cuts out the armature resistor, connecting the motor directly across the line.

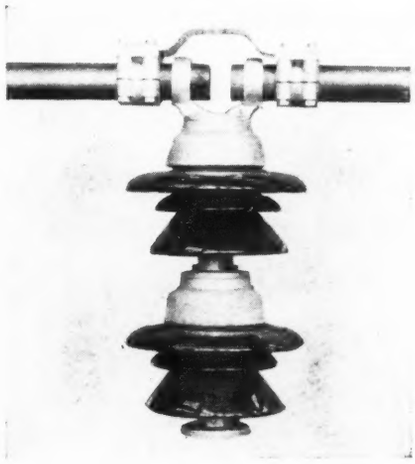
The standard starter is supplied with thermal overload relays of the fusible alloy type and can be made applicable to various size motors by simply changing the heater coils. Starters without the relays are also available. The starter is put out by Cutler-Hammer, Inc., 190, 12th St., Milwaukee, Wis.

Expansion Joint for Aluminum Tube Bus

A NEW form of expansion joint especially adapted for long sections of heavy aluminum tube bus is announced by the Delta-Star Electric Company, Chicago.

To the cap of the standard insulator is bolted an aluminum alloy saddle with two projections, the interior surfaces of which are cone shaped. The tubular bus resting on these rounded surfaces is free to move and there is no binding due to conductor sags or misalignment of the bus.

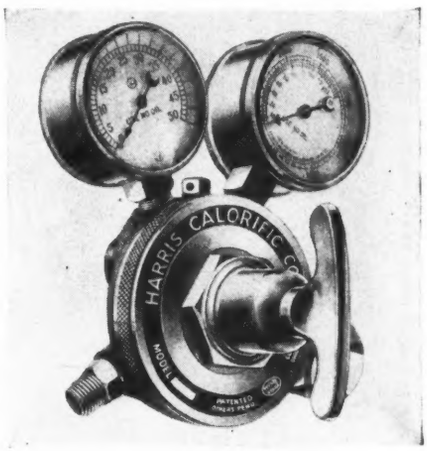
To each section of the bus is clamped a sheaf of thin flexible aluminum strips, which permit moving of the tubes as they expand or contract. All the bolts and nuts are made of duralumin.



Bus bar support with flexible connection between buses

Multi-Stage Regulator for Gas Cylinders

THROUGH the use of multi-stage reduction of the gas pressure in the cylinder to the pressure at the welding torch, the "Multi-Stage" regulator, manufactured by the Harris Calorific Company, Cleveland, Ohio, gives uniform pressure at the welding tip. The pressure reduction is accomplished in two stages. The first-stage reduction is from the cylinder pressure down to a constant sub-pressure, from whence the gas is passed to a second stage and then



Two-stage pressure regulator

to the torch. The multi-stage reduction permits the use of seats of different characters, each best suited to its function. The first seat is used for holding the cylinder pressure of about 2,000 lb., whereas the second is used only for controlling it.

All parts of the regulator are accessible, and forged material is used throughout. With the adjusting screw set at the working pressure, the full cylinder pressure may be turned on without injury to the regulator. Sand and dust accumulated in cylinder valves can be blown into the regulator without disturbing its functioning, since a protective cartridge is employed.

Endless Cord Transmission Belt

A NEW design of endless cord transmission belt designated "Compass" is announced by Goodyear Tire and Rubber Company, Inc., Akron, Ohio.

The belt, according to the manufacturer, differs from ordinary fabric belts made endless with a splice in

Belt has a core of cords embedded in rubber

that it has no splice in the core of cords which carry the load. The cords are embedded in rubber, and are covered by an elastic, rubberized, fabric envelope. This envelope takes all of the surface wear, and since it is elastic, all of the load is properly thrown on the load-carrying cords.

The belt, it is claimed, is practically stretchless, extremely flexible, and much thinner than standard belts of equal power capacity. It is especially recommended for drives on air compressors, vacuum pumps, ice machines and similar equipment, and on short-center and high-speed, small pulley drives.

The belt is also available in cut lengths for oil field work and for cone drives in textile plants.

Corrosion-Resisting Steel

A CORROSION - RESISTANT steel intended to resist the action of hot weak solutions of sulphuric acid is being produced under the name of "Durimet" by the Duriron Company, Inc., Dayton, Ohio. Three varieties of the steel are available, listed as "A," "B," and "D," all containing high percentages of nickel and silicon. Grade A contains 25 per cent nickel, 5 per cent silicon, a trace of chromium, and 0.25 per cent carbon. Grade B contains 35 per cent nickel, 5 per cent silicon, 12 per cent chromium, and 0.25 per cent carbon. Grade D contains 15 per cent nickel, 3 per cent silicon, 2.5 per cent chromium, and 0.60 per cent carbon.

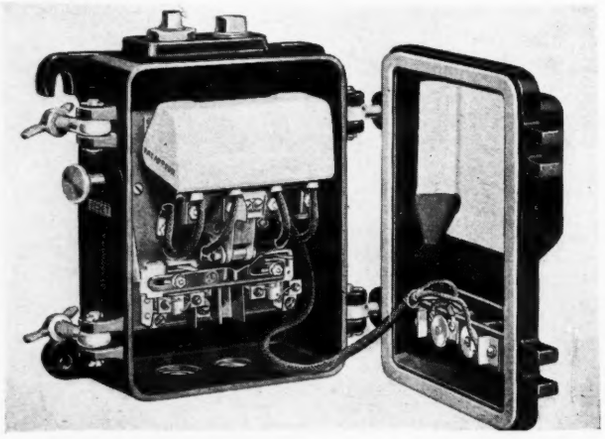
The A and B grades can be furnished in the form of hot- or cold-rolled bars, sheets and plates, ground and polished shafting, wire, rivets, bolts and nuts, and castings. The D grade, at the present time, is furnished only in the form of castings. The B grade metal shows good resistance to hot glacial acetic acid, and can be used for ventilating fans and ducts, towers, and similar equipment handling entrained sulphuric acid and laboratory fumes. The D grade has approximately the same acid-resisting qualities as the A grade.

Splashproof Motor-Starting Switch

DESIGNED especially for use in plants and industries where wash-downs of equipment are essential or where excessive moisture or dust is present, the splash- and dust-proof starting switch illustrated is rated up to 3 hp. 110 volts, 5 hp. 220 volts, single-phase and 7½ hp. 440 and 550 volts for polyphase motors.

It is equipped with two resistotherm relays which provide overload and phase failure protection and which can be reset without opening the cabinet by operating a lever in the cover.

The switch, which is put out by the Allen-Bradley Company, 286 Greenfield Ave., Milwaukee, Wis., is furnished in three forms. Form 1, with push buttons in cover; form 2, for external pilot control and form 3 with two-way lever switch.

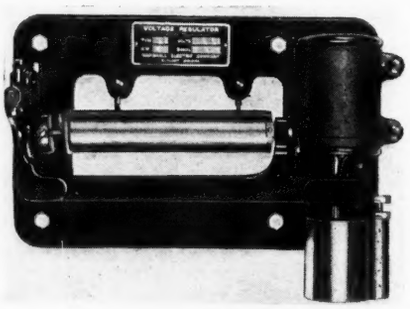


Moisture- and dust-proof starting switch for single- and poly-phase motors

Automatic Voltage Regulator for Generators

AN automatic voltage regulator for alternating- and direct-current generators from the smallest to the largest system is announced by the Marshall Electric Company, Elkhart, Ind. It consists of a carbon pile resistance unit in series with the field of a direct-current exciter or generator. The carbon pile is compressed by gravity and released by an electromagnet. The weight of the parts and the pull of the magnet balance. No springs are used.

In conjunction with the large direct-current generators, and exciters for large generators, the regulator is used to adjust the speed of an adjustable-speed motor-driven rheostat or a large magnet-operated rheostat. There are no make-and-break contacts of any kind. The adjustment is simple and when once set will remain in that setting.



Voltage regulator employs carbon pile resistance units

These regulators are in use as speed regulators on adjustable-speed, shunt-wound, direct-current motors on paper-making machinery. They are also suitable for assisting synchronous alternating-current motors on exceedingly variable loads in maintaining power factor.

Recent Developments in Boiler Feed-Water Treatment

In this abstract of his paper presented at the Toronto Convention of the American Water Works Association Mr. Powell shows in a broad way where progress is being made in the field of feed-water treatment to prevent the formation of scale, corrosion of boiler metal, acid steam, etc.

By Sheppard T. Powell
Consulting Chemical Engineer
Baltimore, Md.

IT IS difficult to evaluate the developments in any art without relatively long experience to establish the worth of such progress. A survey of conditions in this special field of engineering may prove helpful, however, to indicate the trend of thought and achievement. Steam station practice has undergone such radical changes in the past ten years that it is difficult to realize the importance of feed-water treatment and allied procedure without a conception of the manifold problems resulting from these rapidly changing conditions.

The economic phase of these problems also has awakened keen interest among engineers, which in turn has directed attention to the necessity for research. At no time in the past has as much thought been given, both in this country and abroad, to corrective water treatment as during the past year. This is especially true in Germany, where a number of co-operative research investigations, similar to those in progress in this country, are now under way

Local conditions have a marked influence upon feed-water problems, yet fundamental knowledge of water conditioning is the foundation upon which the solution of the problem ultimately must rest. With this conception of water treatment for industrial use now quite general among American engineers responsible for the safe and economic operation of steam-generating equipment, much time and effort have been expended in such research. At least two important investigations have been tentatively arranged. The mechanism of priming and foaming of water under steam conditions and the determination of the hydrogen-ion concentration of concentrated boiler water under steam conditions are examples. The results of these studies should do much to extend our knowledge of two of the most perplexing problems in steam boiler operation, i.e., wet steam and corrosion of boilers and appurtenances.

Combination of Processes

Possibly the most interesting recent engineering development in feed water treatment has been the combination of various forms of water-purification processes. The combination of chemical and zeolite softening, additions of coagulants with softening reagents, the continuous blow-down system and steam purifiers have revolutionized feed-water treatment. This has made possible a broader field for the designing engineer.

The conditioning of feed water is no longer limited to a single process, but to a series of corrective treatments. The design will depend upon the steam station requirements and the economy resulting from the combination treatment. Recirculation of concentrated boiler waters, although used in the past, has not been widely employed. Recently a number of novel applications have been made which are attracting attention, since they have merit for specific conditions. In some of the designs recirculating only with heat recovery is effected, while in others partial softening also takes place.

Phosphate and Sodium Aluminate Treatment Gaining Favor

No new chemicals of importance have been produced for water conditioning, but there has been a marked increase in the use of some softening reagents. This is particularly so in the case of phosphates and sodium aluminate. The increased use of these reagents is due primarily to purer products and to more exact knowledge of their value for specific conditions. The investigations to determine methods of water treatment to inhibit embrittlement of boiler steel has been partially responsible for the increased use of phosphate. Both di- and tri-sodium phosphate have been used in the past. Mono phosphate has been now offered for this service. This product has some advantage over the other sodium salts, since the desired soluble phosphate is obtained with a lesser concentration of the sodium radical.

Inhibition of corrosion of boilers, heaters and condensers by electrolytic methods has continued to attract attention, and a number of successful installations has been made during the past few months. Research has been conducted at at least two universities in an effort to determine the cause of these phenomena. A number of hypotheses have been advanced to account for this form of protection, but experimental data are lacking to account for the mechanism of retardation of corrosion.

A number of valuable contributions to the art of industrial water treatment have been made recently. Possibly the most constructive study in reference to the mechanism of scale formation has been that of E. P. Partridge, at the University of Michigan. The data presented by this investigator have thrown new light on deposition of scale, forming solids and should prove of value in directing attention to future methods for controlling scale formation in evaporators and in boilers. Work along similar lines is to be carried on by others. The results will be awaited with interest, since they may lead to revolutionary changes in conception of scale growth.

A number of valuable contributions relating to embrittlement of boiler steel have been made through the Verein Deutscher Ingenieure. Likewise, the work of Thiel and Luchmann[1] on the same subject will be found instructive in reference to the German investigators' viewpoint on this important problem.

Gases in Steam from Dissociation

Many new problems have been encountered, which may not be solved without more intimate knowledge of the chemistry of water. The presence of non-condensible gases in steam, especially carbon dioxide, has given much concern to those responsible for steam station control. Acid steam from this source is much more frequent than is usually suspected. No solution for the control of the difficulty is at present available. The dissociation of even pure water in steel economizers and superheaters has been shown recently to be a possibility under certain conditions. The detrimental effect on steel, from such dissociation products, is well known and must be avoided, since the resulting damage is permanent and may be very costly.

The problem cannot yet be discussed with authority, since much study must be given to it over a wide range of conditions before the extent and acceleration of this destructive action on steel may be determined accurately. The report on this subject by C. H. Fellows shows these dissociation possibilities of water. One industrial concern is now conducting similar experiments at pressures up to 4,000 pounds.

The aim of this group to solve these problems by co-operative effort has been recognized as a constructive program involving the least duplication of effort. This movement has attracted attention from similar European groups, and tentative plans have been arranged to exchange ideas with at least one of these co-operative research associations. Such international exchange of ideas should be mutually beneficial.

There must necessarily be more or less lost motion in carrying forward any co-operative work of this kind. There are so many problems peculiarly important to each group that it is not possible to confine the work of these committees to any specified plant-control measures. The most that can result from this work is to establish fundamental concepts and to arrange these data for practical use.

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[1]Committee Report on Feed Water Studies of the Association of Large Boiler Manufacturers.

FROM AMONG READERS' PROBLEMS

Conducted by L. H. MORRISON

CONVERSION OF INCHES OF VACUUM TO POUNDS PER SQUARE INCH.—*What pressure per square inch would be equivalent to 26 in. vacuum?* E.C.H.

A column of mercury 1 in. high at ordinary temperature exerts a pressure of 0.491 lb. per square inch, and "inches of vacuum" signifies the number of inches of mercury-column pressure less than the pressure of the atmosphere at the place of observation. When a vacuum gage indicates 26 inch vacuum, the pressure is $26 \times 0.491 = 12.766$ lb. per square inch less than the pressure of the atmosphere. The absolute pressure of the atmosphere varies with the elevation of the place. At sea level it usually is assumed to be 14.7 lb. per square inch, so that at sea level the absolute pressure for 26 in. vacuum would be, $14.7 - 12.766 = 1.934$, or practically 2 lb. per square inch absolute.

MAXIMUM ALLOWABLE WORKING PRESSURE FOR CYLINDRICAL BOILER SHELL—*With a factor of safety of 6, what would be the highest allowable working pressure for a cylindrical boiler shell 72 in. in diameter, made of ½-in. steel plate of 55,000-lb. tensile strength and 85 per cent efficiency of longitudinal joint?* E. E. S.

The formula for determing the maximum allowable working pressure for a cylindrical shell is

$$P = \frac{TS \times t \times E}{R \times FS}$$

in which

P = Maximum allowable working pressure, lb. per sq.in.
TS = Tensile strength of shell plates, lb. per sq.in. cross-sectional area.
t = Minimum thickness of shell plates, in inches.
E = Efficiency of longitudinal joint.
R = Radius = one-half the inside diameter of the outside course of the shell, in inches.
FS = The lowest factor of safety allowed.

Substituting the given values, the formula gives

$$P = \frac{55{,}000 \times 0.5 \times 0.85}{36 \times 6} = 108.2 \text{ lb. per sq.in.}$$

maximum allowable working pressure.

EQUALIZING CUTOFF OF CORLISS ENGINE—*How is the same point of cutoff obtained for opposite ends of the cylinder of a Corliss engine?* R. T. C.

Make a mark on the crosshead and corresponding marks on the guide when the piston is at each end of its stroke, and another mark on the guide to indicate where the mark on the crosshead will stand when the piston is at one-quarter stroke from each end of the cylinder. With the wristplate hooked up and the governor blocked to the average running height, place the piston at one-quarter stroke from each end and adjust the length of the governor reach rod to the valve on the same end, so the valve will be just tripped when one-fourth stroke is reached. Then turn the engine over slowly and observe whether cutoff takes place as the piston is brought up to one-fourth stroke from the other end of the cylinder.

If cutoff takes place too early, lengthen or shorten the governor reach rod to the valve of the same end so that it will not take place until after one-fourth stroke; or if cutoff was found to take place too late, gradually adjust the length of the reach rod so the valve is just tripped when the piston is brought up to one-fourth stroke.

If there is a single reach rod from the governor with a link connection between the valves, adjustment should first be made of the rod that has direct connection with the governor. When adjustments are made, test the equality of cutoff when the governor is blocked a little higher and also when blocked a little lower. On account of variation of angular position of the governor connections, it is impossible to make adjustment that will obtain exact equalization for all positions of the governor, but when made for any particular position, equalization for the average load can be made by adjusting the cutoff of one end of the cylinder checked by indicator diagrams.

CHROME ITCH IN ICE PLANT—*We have added sodium dichromate to our brine tank to prevent corrosion, and the ice pullers claim that it causes an itch or skin eruption. Is this true?* P. S.

A dichromate will cause what is known as "chrome itch." To guard against this the ice pullers should wash their hands, face and neck, several times a day. If this is done no trouble will appear. Surprisingly, the pigment in a negro's skin seems to prevent the occurrence of the itch.

LIFT OF SAFETY VALVE—*How can I find the lift of a spring loaded safety valve?* E. G. W.

With the ordinary safety valve the spring is covered, and to measure the lift when popping, the cap must be removed. The deflection of the spring can be measured and taken as the valve lift.

CORRECTNESS OF INDICATOR DIAGRAM—*Can the correctness of an indicator diagram be checked, and how?* J.S.

An indicator diagram may be in error by reason of defects in the connecting piping, in the indicator cord, in the reducing motion and in the adjustments of the indicator itself. To check the correctness of the diagram, these several points must be examined.

TURBINE HUNTS—*In our power plant we have an 800-kw. 480-volt 1,208-amp. 3,600-r.p.m. 60-cycle turbine-generator. While the load is on, we carry 27 in. of vacuum, and the steam pressure at the turbine is about 165 lb. gage. The speed of the machine varies from 3,650 r.p.m. down to about 3,450 r.p.m. When the load is suddenly taken off, as at noon time, the vacuum rises to 29 in., the turbine speeds up and, if the pressure at the pressure reducing valve is not lowered, the machine will trip out.*

Our usual procedure when the load is taken off, is to cut the pressure at the turbine from 165 to 100 lb. This has to be done at the instant the load is knocked off, or the machine will reach a speed of 3,700 r.p.m. and trip out. To make sure of the machine's not tripping out, we cut down the speed well below 3,600 r.p.m. just before the load is taken off. When the turbine is running light, just after the load is off, the machine hunts and takes its steam in puffs, slowing down and speeding up at intervals. Sometimes we can stop this by regulating the pressure leading to the diaphragm on the pressure-reducing valve, while other times it is difficult to stop. What is the trouble and remedy? D.G.

The hunting or surging is due, probably, to a gummy governor. If the governor weights cannot shift the valve gear at a normal increase in speed, it is evident that when the weights revolve at a much greater velocity the valve gear will be shifted suddenly and the travel will be greater than necessary to bring the valve to its correct position. This overtravel cuts off the steam, and the turbine slows down until the governor can again shift the valve open. In so doing, a second over travel occurs. The remedy is to overhaul the governor.

The trip is set too close to the running speed. When the load drops from full to no load, the speed regulation should not be expected to be better than 5 per cent, which calls for a speed of 3,780 r.p.m. The overspeed trip should not act until the speed reaches, 3,800 revolutions per minute.

FLASHING POINT OF FUEL OIL—*What is meant by the flash point of a fuel oil, and what do the "open" and "closed" tests consist of?* W. T. D.

The flashing point of an oil is that temperature to which the oil must be heated, at a specified rate, to cause it to give off a vapor which will ignite when mixed with air and exposed to a flame near the surface of the oil.

The "open test" consists in heating some of the oil, in which the bulb of a thermometer is placed, in a small open metallic cup, a porcelain crucible embedded in sand or some equivalent contrivance, heated by application of a gas flame or other source of heat that is under the control of the experimenter, so that the temperature of the oil increases at the rate of 10 deg. F. per minute. A small flame from a taper or gas tube is passed across the surface of the oil for every five degrees rise in temperature until the vapor ignites or flashes. The temperature at which this flash is first observed is taken as the flashing point of the oil.

The open-cup method is beset by uncertainties. The temperature at which the first flash is obtained depends on the presence or absence of air currents, the actual rate of heating, the size and shape of the vessel containing the sample, the distance of the flame from the oil surface and the skill of the experimenter.

The closed test, as the name implies, is performed with apparatus from which air currents are excluded and in which the oil and vapor are stirred and the heat applied may be so regulated that when the temperature nears the flash point, the rise in temperature is so reduced that the testing flame may be quickly applied to the surface of the oil every two degrees rise of its temperature until the flashing point is reached.

Open-cup testing usually gives 5 to 25 deg. higher flash point than closed-cup testing, and the presence of much moisture causes irregular and incorrect results by either method of testing.

OPERATION OF RECIPROCATING AND CENTRIFUGAL PUMPS IN PARALLEL—*Can a centrifugal and a reciprocating pump be operated in parallel for boiler feeding?* J.K.

When a centrifugal discharge is connected into a feed line through a Y-branch, it can be operated in conjunction with a reciprocating pump discharging into the same feed line provided the reciprocating pump is fitted with an air chamber that prevents pulsation of the discharge and is not operated fast enough to maintain a feed-pipe pressure higher than the pressure that can be built up by the centrifugal. As the action of the reciprocating pump will be positive, the delivery by the centrifugal will not be parallel in the sense of bearing a constant ratio, but will be the additional flow that can take place through the check valve and the feed-pipe connections at the highest pressure that can be built up by the centrifugal.

A Question For Our Readers

THE formula for calculating the sensible heat contained in the dry flue gas per unit of fuel burned is: Weight of gas × specific heat × (T — t) = B.t.u. If T is the temperature of the gas on leaving the boiler, what temperature should t equal —that of the boiler room or of the air outside, and why? E. A. U.

Suitable answers (of 200 words or less) from readers will be paid for and published in the Dec. 24 issue.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

AN oil-fired boiler not properly equipped with soot blowers has accumulated on the outside of the tubes a thick deposit of hard-baked, asphaltum-base scale or slag. What is the easiest and most economical means of removing this slag prior to the installation of soot blowers? W. B.

THE soot is evidence that the boiler furnace is not being operated properly. If the burners are adjusted to give the correct atomizing, and the air registers set to give the correct amount of air, no soot will be deposited.

The proper answer to the question is not how to remove the soot, but rather how to prevent future deposits. Many firemen think they can judge a flame by its color, but an amount of excess air that may so chill the oil as to cause carbon may not materially affect the color of the main mass of flame. Then, too, the presence of a white-hot bridgewall will give the flame an appearance of perfect combustion, when, in fact, there is imperfect mixing.

On the other hand, many firemen run oil-fired boilers with too little air, or let the air registers get out of order.

If my boilers showed a lot of soot on the tubes I would set to work to find out what CO_2 and excess air I was getting. I would get busy and borrow an Orsat analyzer. Then I would talk the manager into purchasing an indicating CO_2 machine.

All this has been about how not to have soot. With the soot already in existence I would make a strong attempt to burn it off by raising the temperature and length of the oil flame. If the oil is shot into a checker-work bridgewall, I would remove part of the wall so that the flames could reach up through the passes. Then by adjusting the air register I would reduce the air supply to raise the furnace temperature.

If there is an induced draft, the soot can be removed by shoveling sand into the air stream entering the furnace, just as the railroad fireman cleans locomotive tubes.

Also, there is the famous "shot-gun" method, wherein a shot gun is loaded with fine shot and fired through the inspection doors. A few shots will blow off a lot of scale and will not hurt the boiler tubes.

Many plants are trying to burn a heavy-residue oil, almost "tank bottoms," without straining or heating it. Such oil when cold will not burn completely, and if dirt lodges at the burner tip, the burner will dribble and soot will surely appear at the tubes.

D. CARLOS GRACIAS.
Havana, Cuba.

THE easiest and most economical method of removing soot from an oil-fired boiler is to wash the soot off the tubes with water. The soot becomes quite soluble in the presence of water and readily leaves the tubes.

After the wash, and prior to lighting up the furnace, give the tubes a coating of a mixture of French-zinc powder diluted with water. The mixture resembles ordinary whitewash.

After the fires have been started and the brickwork has become hot throughout the furnace, throw in from 3 to 5 lb. of the chemical "Chimnee Sweep," which is a mixture of chlorides, zinc sulphur and carbon. This should be done once a week thereafter. This treatment will effectively prevent soot formation.

The advisability of installing a soot blower on an oil-fired boiler is extremely questionable, unless the metal-heating surfaces of the boiler are set high enough to receive only the gases resulting from efficient combustion.

If the boilers are set low, as they must be in the case of those operated by "W. B.," since asphaltum-base scale or soot deposit are noted on the tubes, soot blowers will not effectively keep the heating surfaces clean, without the application of the treatment outlined.

E. A. BAERER.
Bayonne, N. J.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

Spot * News

THE SUPREME COURT *of Oklahoma has held that the revocable permit law of 1925, permitting public utilities to surrender a municipal franchise and obtain a permit from the State that was revocable only by legislative action, is unconstitutional.*

* * *

WOODEN SHOE PEGS *were used recently as fuel for the power plant of the town of Bekescaba in Hungary. A large consignment of these pegs from Russia were left stranded at the local custom house because they were not as ordered. The customs officials finally decided to dispose of them to the town generating station.*

* * *

TO DETERMINE *the amount of interstate transmission of power the Senate has adopted Senator Couzens' resolution directing the Federal Trade Commission to investigate the subject and report on the amount of electricity consumed in a state and the amount generated there.*

* * *

A TOTAL *of 500,744,970 net tons of bituminous coal was produced by mines in the United States during 1928, according to figures just made public by the Bureau of Mines. Of this amount 467,347,915 tons were loaded for shipment at the mines, the remainder being mine fuel, coal made into coke at the mines and coal sold to the local trade.*

* * *

DUE TO THE FAILURE *of the W. B. Foshay Company, of Minneapolis, Minn., the Public Utilities Consolidated Corporation, an Arizona corporation formed more than two years ago as a utility holding company of Foshay, has entered voluntary receivership to protect its holdings.*

* * *

WIDESPREAD DROUGHT *in many parts of the country during the past several months has necessitated the production by steam plants of nearly 3,000,000,000 kw.-hr. more than they were called upon to furnish in 1928. Approximately 2,600,000 tons of fuel have been consumed to make up for the deficiency in rainfall.*

Applicants Raise Many Objections to Boulder Dam Allocations

CONFRONTED with threat of litigation by Nevada that would suspend work on the Boulder Dam project until the Supreme Court of the United States rules on the constitutionality of the act, the conference, Nov. 12-13, of the other beneficiaries produced little but a restatement of their conflicting demands. The allocations tentatively suggested in Secretary Wilbur's statement of Oct. 21 published in *Power*, Oct. 29, apparently were not acceptable to any of the parties. The suggestion advanced by Ward Bannister, counsel for the city of Denver, that the power contracts should not be drafted until another effort is made to bring Arizona into the Colorado River compact was received without comment.

Spokesmen for the State of Nevada reiterated their demand for allocation of one-third of the power developed by the dam, representing that the allocation of 18 per cent proposed in Secretary Wilbur's statement made the interests of that state subservient to those of municipal and private interests. They also contended that until such time as this power is required in the industrial development of the state that it should be permitted to sell it outside of its boundaries.

Secretary Wilbur stated that the preference rights of the states of Nevada and Arizona are recognized and that he is anxious to reach a solution of the problem that will protect their interests to the end that they can obtain power when and as they need it. On behalf of the city of Los Angeles and the metropolitan water district, W. B. Matthews stated that they would be glad to negotiate with the two states an agreement providing for utilization of the states' surplus subject to drawback from time to time.

The proposals presented at the hearing by the spokesmen for the city of Los Angeles and the metropolitan water district were as follows: The city should be designated as the sole agent in charge of operation of the power plant and the main transmission lines. If allocation of power without a hand in control is not acceptable to the private companies the city can use it and is able to pay for it. The government should build the plant and install the machinery. The proposed board of control should function only in an advisory capacity and should be recast to include one representative of the private companies, one of the city of Los Angeles, two of the metropolitan water district and one or more of the government. The dam should be erected to the greatest height feasible.

The Southern California Edison Company protested that the proposed division of power is inequitable and unfair to the customers of the public utility companies and contrary to the public interest, which is the controlling consideration under the law for the allocation of power. While the company is in entire accord with the plan to make available to the metropolitan water district all the power needed for pumping water into the Colorado river aqueduct, the company objects to the plan to make the district a direct and principal contractor. The company contended that the district can be wholly protected as to its needs for power for pumping water by a provision in the contracts giving to the district a drawback right as and when its need for power arises. To give the district a direct allocation and contract for either a definite or indefinite power would result inevitably, the company's spokesman argued, in the expansion of the district's activities to include power distribution to its particular cities. Evidence of this intention, it was stated, was given in the resolution passed at the last meeting of the district's board of directors.

German Engineers Visiting U. S. Power Plants

A group of six German electrical engineers is now making a tour of the United States with the object of visiting several large power plants and electrical organizations in this country. Comprising the group are: Hermann Zilian and Karl Swoboda, managers of the Stadtische Technische Werke, Leipzig; Albert Frey, manager of Elektra Markgedflerland G.m.b.H. Haltingen, Lorrach; W. Berndt, manager of Electrizitats Lieverungsgesellschaft, A.G. Siegmar-Chemnitz; Wolfgang Hartel, Leipzig; Herr Korff, manager of Electrizitatsverband Groba, Kotzschenbroda.

Included in the itinerary of the trip was a sight-seeing tour through New York City Nov. 4 to 7, during which the group visited power plants of the New York and Brooklyn Edison companies, Pennsylvania Railroad and Grand Central stations and many of the large buildings. On Nov. 8 they pro-

ceeded to the General Electric Company works at Schenectady, N. Y., and on to the large power stations at Niagara Falls. Arriving in Detroit on Nov. 12, they inspected the Ford plant, General Motors Building, and the Trenton station of the Detroit Edison Company. Their sojourn in Chicago from Nov. 13 to 17 included trips to the great meat-packing plants, the Crawford power station and an excursion to the Lake Side plant at Milwaukee. Nov. 18 was spent in Pittsburgh, looking over the Westinghouse Electric works.

The German engineers arrive in Washington today, and will spend two days inspecting government buildings and points of historic interest. They will proceed to Philadelphia Nov. 21 for a visit to the Conowingo hydro-electric plant. Returning to New York on Nov. 22, the group will sail for home next day on the SS. "Deutschland."

Stoker Manufacturers Hold Annual Meeting

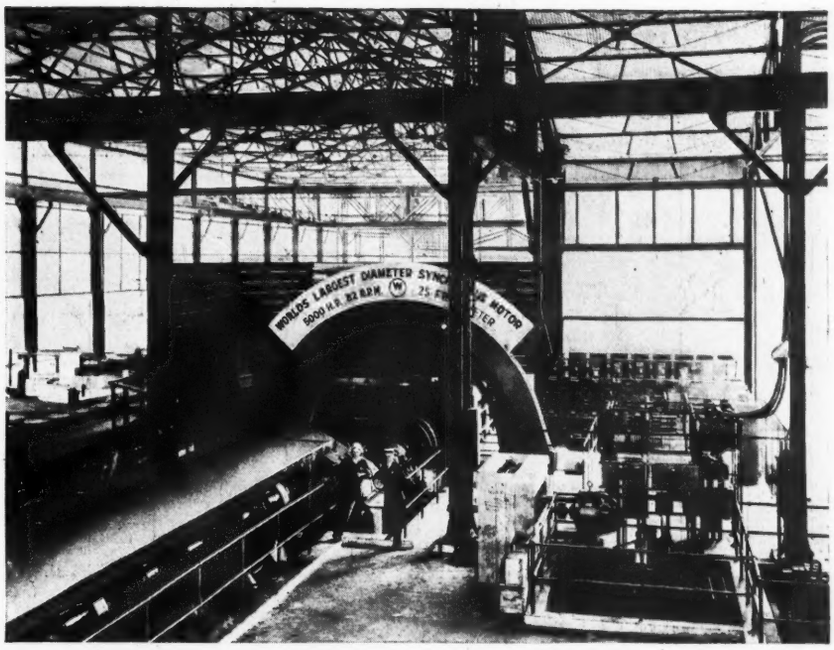
The fall meeting of the American Stoker Manufacturers' Association was held at the Greenbrier, White Sulphur Springs, W. Va., Nov. 11-13. In the absence of the president, Col. H. D. Savage of Combustion Engineering Corporation, Vice-President Joseph Worker, of the American Engineering Corporation, presided. Although the attendance was smaller than usual, the meeting was marked by frank and cordial discussion of the problems of the industry and an apparent resolve for united endeavor to maintain a high standard of ethics and increased service to the users of combustion appliances.

Power Piping Standard Drafted by A.S.A.

Standards for power piping systems and mechanical refrigeration, among others, are now being worked on by the American Standards Association, according to its latest report of activities.

A draft of the proposed American recommended practice for power piping systems, which is section two of the code for pressure piping, is being circulated for review and criticism. The draft was prepared by a sub-committee under the chairmanship of John H. Lawrence, president of Thomas E. Murray, Inc., and covers the design, manufacture, testing and installation of power piping systems in steam-generating stations, central heating plants, industrial process work and all distributing systems where the pressure is in excess of 15 lb. per square inch. Other sub-committees are at present working on hydraulic piping systems, gas and air piping systems, refrigerating piping, oil piping, materials and fabrication details.

A sub-committee of the A.S.A. sectional committee on mechanical refrigeration has just completed a new draft of the code on this subject. The committee is working under the sponsorship of the American Society of Refrigerating Engineers. In preparing the new draft, the sub-committee carefully considered the recent series of accidents with multiple installations of refrigerators in the Chicago area. The section of the code dealing with multiple installations is believed to offer a satisfactory solution of this problem.



USED to drive a 22-in. continuous bar mill at the Columbia Steel Corporation, Pittsburg, Calif., this Westinghouse motor is the largest diameter synchronous motor in operation, being 25 ft. It has 88 poles and operates on a three-phase, 2,200-volt system with an output of 5,000 hp. at 82 r.p.m. and 100 per cent power factor.

Large Diesels to Replace Steam at Mines

Six oil engines, comprising the largest Diesel plant in the world, will be installed in a central generating station by Australian mining companies at Broken Hill in New South Wales, to replace individual steam plants which have hitherto been separately serving the various lead, zinc and silver mines in the district. Decision to make the change has been brought about by the increasing cost of coal, which is now quoted at nearly $16 a ton in New South Wales.

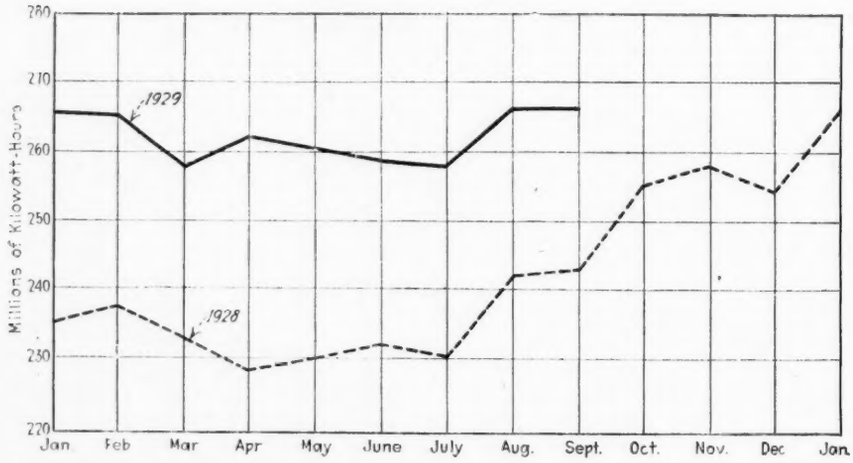
The new central plant will consist of six two-cycle engines, manufactured by Sulzer Brothers of Winterthur, Switzerland, each developing 2,900 b.hp. and direct coupled to a 2,500-kva. flywheel generator, producing three-phase current at 6,900 volts. Four Diesel-engine driven compressor sets, each of 1,230 b.hp., are provided for supplying compressed air. When the power station is completed, the normal output will amount to 22,300 b.hp., and, as the engines can temporarily be run at 20 per cent overload, the maximum total output will be 27,800 b.hp. The output of the Broken Hill power station therefore will be greater than that of the Diesel plant which has hitherto been the largest in the world, the station at Shanghai.

Colorado Public Service Plans Expansion

The largest budget ever contemplated by the Public Service Company of Colorado for improvement and rehabilitation work has been announced by Clare N. Stannard, vice-president and general manager. The amount to be spent totals $4,673,000 and was necessitated by greatly increased demands for electricity and natural gas. Mining revival in Colorado and a number of big industrial installations in Denver are contributing factors.

Coincidental with the release on budget figures, Mr. Stannard disclosed that the Public Service Company of Colorado established a peak of more than 1,000,000 kw.-hr. Oct. 29. A heavy percentage of the increased electric load falls on Valmont, the company's 65,000-hp. steam-generating plant near Boulder, Colo. To pick up this added burden a new boiler costing half a million dollars will supplement the Valmont equipment. Additions to outlying hydro and steam plants and an ambitious program on high-voltage tie lines constitute outstanding items on the 1930 schedule.

Utility Power Production Continues at High Level



AVERAGE daily production of electricity by public utility power plants throughout the country during September was 266,600,000 kw.-hr., practically the same as the all-time record rate established during August of 267,300,000 kw.-hr. per day. On account of September being a 30-day month, the total output for the month was less by about one day's average output than the total output for August. An examination of the curves of average daily output shows that the total daily outputs for 1929 and 1928 are practically parallel for the period from June to September, indicating that the demands for electricity were about the same during this period in each of these two years.

The continued drought during September decreased the flow in the streams of the country, with a corresponding decrease in the production of electricity by the use of water power. The proportion of the total output of electricity generated by the use of water power was only 31 per cent in September. This is the lowest ratio since October, 1925. The rains which have occurred in October will improve the water power situation. Fuel-burning plants have fortunately been able to take care of the demand resulting from decrease of output by water-power plants. The total output for September was 10 per cent greater than for September, 1928. The kilowatt-hours of electricity by water power in September of this year was 12 per cent less than in September of last year. The output by the use of fuels in September of this year was 23 per cent greater than for September, 1928.

These figures and curves were compiled by A. H. Horton of the Division of Power Resources, Geological Survey.

Detroit Edison to Add to Connors Creek

Plans for the installation of new 75,000-kw. tandem-compound turbines in the Connors Creek power station have been announced by the Detroit Edison Company. A new switch house will be built at the station to provide the necessary room for the additional turbines. Only the low-pressure units of the turbines will be installed at first, according to present specifications. The boilers and steam pressures now in service will be used with a possible change in superheaters to raise the temperature of the steam to 700 deg. When the high pressure units are added the station pressure will be raised to at least 600 lb., and new boilers will be installed. Steam auxiliaries, including boiler-feed pump and heater condenser system, will have to be scrapped. Bleeder heaters with combination pumps, similar to those now at Trenton Channel and Delray No. 3, will be added. Probably none of these changes will be made before 1931.

Liquid Fuels Test Code Ready for Hearing

A test code for liquid fuels, prepared by Power Test Codes Individual Committee No. 3 on Fuels, of which Walter J. Wohlenberg is chairman, is ready for the public hearing to be held during the annual meeting of the American Society of Mechanical Engineers in New York City, Dec. 2. The code is intended primarily to specify standard methods for determining the chemical and physical properties which serve as indicators of the value of those liquid fuels used extensively in the generation of heat and power.

In the preparation of this code, the committee has worked in close cooperation with the American Society for Testing Materials Committee D-2 on Petroleum Products and Lubricants. Certain of the A.S.T.M. specifications have been adopted as standards in the present code. The committee preparing the latter code is an offshoot of the Main Committee on Power Test Codes, of which Fred R. Low is chairman.

News of Canada

Prince Edward Island Issues No Engineers Certificates—British Columbia License Regulations

By Campbell Bradshaw
Toronto, Ont.

ON Prince Edward Island there are just six power plants, two of them operated by steam, the remaining four by water. With such limited demand for the services of engineers the province has found it unnecessary, so far, to issue certificates of competency or exact examination or license fees.

Unlike Quebec, Ontario and most of the other provinces of the Dominion, no power-generation projects are under way in Prince Edward Island, Premier Albert C. Saunders informed *Power*. Owing to the small head of the existing streams it is practically impossible to develop hydro power in the province, he said. Manufacturing activity, too, is somewhat limited as evidenced by the 12,000 population of Charlottetown, capital and industrial center of the island.

B. C. Regulations

In the province of British Columbia, licensing of power plant engineers and the inspection of boilers does not come within the jurisdiction of the Department of Labor at Victoria, but is handled by a Boiler and Machinery Inspection Department, a branch of the province's Workmen's Compensation Board at Vancouver, of which E. S. H. Winn, K. C., is chairman, and A. S. Bennett chief inspector. The board defines the term "engineer" as any person having charge of or operating a steam boiler.

Applicants for examination for the principal certificates of competency issued are required to pay the following fees: first-class, $15.00; second-class, $10.00; third-class, $7.50; fourth-class, $5.00.

To obtain first-class certificates an applicant must be at least 22 years old and have served five years as engineer in charge of a watch of a steam plant of not less than 300 nominal horsepower, or four years as mechanic in a workshop on the making and repairing of steam engines, boilers, etc., and one year as engineer in charge of a watch of a steam plant of not less than 300 nominal horsepower. He must also have been in possession of a second-class certificate for six months.

An applicant for a second-class certificate must be 21 years old and have 4 years' experience as an engineer of a steam plant of not less than 100 nominal horsepower, or 3 years as mechanic in a workshop on the making and repairing of steam engines, boilers, etc., and one year as engineer of a steam plant of not less than 100 nominal horsepower.

A third-class man must be at least 20 years old, and have served two years as engineer of a steam plant of not less than 10 nominal horsepower, or three years as fireman, or two years as me-

chanic in a workshop on the making and repairing of steam engines, boilers, etc., and six months as engineer of a steam plant of not less than 10 nominal horsepower.

For the fourth-class examination an applicant must be at least 18 years of age and have served one year as fireman, or as fireman and engineer, of a steam plant of not less than 5 nominal horsepower, or 12 months as a mechanic in a workshop on the making and repairing of steam engines, boilers, etc., and six months as fireman or engineer of a steam plant of not less than 5 nominal horsepower.

When workshop service has been performed in a place where engines are made or repaired, and the candidate has no service as engineer, three years' additional workshop experience may be accepted in lieu of engine room service, provided the chief inspector is satisfied that the workshop service has been such as would fit the candidate for a position as engineer of the grade for which the application is made.

In this province "engineer in charge of a watch" means being on watch for at least eight hours a day, and being responsible for the regulation of the feed water and the general supervision of the boilers and engines during that period.

Business Forecast

THE records for October and the early weeks of November show that a slow and irregular business recession is going on. This is not general; it has, as usual, affected the basic industries more than general trade; and in only relatively few instances has it yet brought the current level of manufacturing activity and trade below that of last year. Part of this decline, especially in the basic industries, is seasonal or a natural reaction to the excessive expansion during the first half of this year; but part is undoubtedly due to the gloom and uncertainty growing out of continued security price deflation. This situation has tended to accentuate the decline in commodity prices that has been going on since July, especially in those raw materials where stocks are large.

In this instance we may expect business to recover somewhat more rapidly than the stock market because of the easing of money and the abundance of funds available for business expansion. Whatever its purpose or its fiscal wisdom, promise of federal tax reduction will help somewhat, but the early and final interment of the abortive attempt at tariff revision, and a moratorium on congressional muckraking this winter would help more.—*The Business Week*, Nov. 16, 1929.

Piez Urges Engineers to Study Business Economics

Speaking at a dinner of the Akron Section of the American Society of Mechanical Engineers, held in the Portage Hotel, Akron, Ohio, on Oct. 22, Charles Piez, chairman of the board of the Link-Belt Company, Chicago, urged engineers to consider the problems of distribution and sales. Tackling these problems with their trained minds, he was sure, they would find not only worthwhile solutions but also increased remuneration for themselves. His address in part is as follows:

"If I had my life to live over again, I am certain that I would start it with

Charles Piez

a course in mechanical engineering, because that represents the best means of acquiring a broad foundation for a useful, practical life, one that not only provides opportunities for a professional career, but also affords abundant opportunity for success in a business career.

"This is true because engineering training develops the ability to dig up and properly weigh the facts before reaching a conclusion, and this ability is the basis of sound judgment in every walk of life.

"But why is it that with this advantageous educational equipment, so relatively few engineers step from the engineering department into high sales, managerial or executive positions?

"The engineer has been responsible for the remarkable improvement in the methods and costs of production, he has become an important, yes, to my way of thinking, the most important factor in the development of industry, yet it is only in rare cases that he dominates it, or determines its policies.

"With increased capacity for production the problems of distribution and finance have become the dominant ones, and for these, the engineer shows no particular leaning nor special aptitude. Some time ago one of our competitors said to me, 'Piez, I think your policy of using engineers in your sales department is a mistake. From my experience they just don't land the bacon. We get better results with bond salesmen. They make a good appearance, know how to approach the prospect, and know how to present the product in the best possible light.'

"There is much to this criticism; that's why I have chosen it as one of the topics for this evening's talk. The bond salesman has had more social experience; he knows that business, like kissing, goes by favor, and he has no over-load of technical formulae to carry around with him. But when you find a man who combines the personality of the bond salesman with the technical training of the engineer, then you have the super-salesman, the salesman we are all looking for.

"The engineer is, first of all, a student, and like the scholar, he is apt to withdraw too much from the affairs of the world. Solitude, rather than society, attracts him. National and State affairs arouse very little interest in him, and so important a matter to industry as the tariff leaves him cold.

"I am talking about the average engineer, the one who is satisfied with his lot because he doesn't know how to change it. Now a knowledge of the tariff, the operation of the Federal Reserve Act, the effect of consolidations on business, chain stores, and other modern devices, may not be necessary to success in pure engineering, but it does broaden one's horizon, and gives one experience in matters that have important bearing on the prosperity of business in general. What I want to do is to *arouse* the engineer to the realization that his *trained mind* can be applied to problems of economics, to those of distribution and sales, with as much chance of finding a worth while solution as in the problems of his own beloved profession."

Session on Power Plants at A.I.E.E. Chicago Meeting

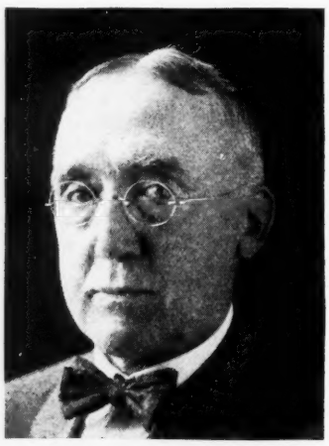
A session devoted to recent developments in power plants will be an outstanding feature of the Great Lakes district meeting of the American Institute of Electrical Engineers, to be held at the Drake Hotel in Chicago, Dec. 2-4. Other sessions include one on research and development, one on transmission and distribution, and two on student activities. Entertainment will be provided by interesting inspection trips to the new State Line and Crawford Avenue generating stations, ladies' functions and a dinner-dance in the ballroom of the Drake Hotel.

Papers to be presented at the power plant session are: "The Future of Higher Steam Pressures," by I. E. Moultrop; "Double Windings for Turbine Alternators," by P. L. Alger, E. H. Freiburghouse and D. D. Chase; "Increased Voltages for Synchronous Machines," by C. M. Laffoon; "A 40,000-kw. Variable-Ratio Frequency Converter," by E. S. Bundy, A. Van Niekirk and W. H. Rodgers; "Use and Design of Fault Ground Bus," by R. M. Stanley and F. C. Hornibrook.

F. L. Beers, Retired Editor, Dies Suddenly

Frederick L. Beers, former assistant editor of *Power*, died suddenly, Nov. 13, of heart disease at the Bridgeport Hospital. He was 70 years of age.

Born near Bridgeport, Conn., Mr. Beers came to New York City on May 24, 1883, the day Brooklyn Bridge was officially opened. For the next fifteen



Frederick L. Beers

years he was connected with publishing interests in various capacities in New York, Philadelphia and Chicago. In 1898 he was employed by the American Machinist Press and continuously served that company and its successors, the Hill Publishing Company and the McGraw-Hill Publishing Company, for 31 years, most of which he spent on the staff of *Power*.

On July 1 of this year Mr. Beers retired from active work, and since that time he had been enjoying leisure at his home in Fairfield, Conn.

Coming Conventions

American Institute of Electrical Engineers. District meeting at Chicago, Ill., Dec. 2-4. Annual winter convention at New York, N. Y., Jan. 27-31, 1930. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting at New York, N. Y., Dec. 2-6. Secretary, Calvin Rice, 33 West 39th St., New York City.

American Society of Refrigerating Engineers. Twenty-Fifth Anniversary Meeting at Hotel Pennsylvania, New York City, Dec. 4-7. Secretary, David L. Fiske, 37 West 39th St., New York City.

American Society of Heating & Ventilation Engineers. Annual meeting in Philadelphia, Pa., Jan. 27-30, 1930, at the Benjamin Franklin Hotel. Secretary, A. V. Hutchinson, 33 W. 39th St., New York City.

International Heating & Ventilating Exposition. Commercial Museum, Philadelphia, Pa., Jan. 27-31, 1930. Manager, C. F. Roth, Grand Central Palace, New York City.

International Congress for General Mechanics at Liege, Belgium, Aug. 31 to Sept. 7, 1930. For information address Alb. Schlag, 4 Place Saint-Lambert, Liege, Belgium.

National Electric Light Association. Annual convention at Municipal Auditorium, San Francisco, Calif., June 16-20, 1930. Secretary, A. J. Marshall, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering. Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Marine Engineers' Beneficial Association. Annual convention at Hotel Barlum, Detroit, Mich., the week of Feb. 10, 1930. Secretary, A. L. Jones, 9th St. and Mount Vernon Place, N. W., Washington, D. C.

Obituary

Robert M. Searle, president of the Rochester Gas & Electric Corporation, committed suicide Nov. 13 at his home in Rochester, N. Y. Depression over losses amounting to $1,200,000 in the recent stock market crash was given as the cause of the act. Born in Peekskill, N. Y., on Mar. 3, 1869, one of Mr. Searle's first jobs was that of office boy for Thomas A. Edison. Later he went to Philadelphia, where he became a boiler fireman for the United Gas Improvement Company. From there he rapidly advanced to executive positions in the public utility field until he became president of the Rochester company.

John Pettit Rigsby, well-known in the central station industry and general engineer at the South Philadelphia plant of the Westinghouse Electric & Manufacturing Company, died suddenly at his home, 30 Morton Ave., Ridley Park, recently, as the result of pneumonia. Mr. Rigsby, who was 51 years of age, was born in Stoneybrook, Ontario. He was graduated in mechanical engineering from the University of Toronto in 1899. After leaving college he began his career as draftsman with the Mesta Machine Company at Pittsburgh. In 1903 he joined the Westinghouse Company in the same capacity.

Henry Aylett Coles, Atlanta district manager of the Westinghouse Electric & Manufacturing Company, died recently in New Orleans, La., of heart failure. A veteran in the Westinghouse service, he had joined the company while its plant was located in Garrison Alley, Pittsburgh. Mr. Coles was born in Tallwood, Albermarle County, Va., August 17, 1870. His education consisted of private instruction and one year at Roanoke College, followed by three years in an engineering course at the University of Virginia. Following graduation in 1891, he spent six months operating an electric light plant in Charlottesville, Va., then entered the employ of the Edison General Electric Company. Leaving there he entered the Westinghouse service.

Personals

H. B. Dirks has been made acting dean at Michigan State College, East Lansing, to succeed G. W. Bissell who has taken an indefinite leave of absence after 22 years as dean at the college. Mr. Dirks was the first assistant at the Illinois Engineering Experiment Station, working high-speed tool steel experiments and fuel tests. Later he was professor of mechanical engineering at Princeton University, and in 1919 became professor of mechanical engineering at Michigan State.

C. J. Silber, formerly in the construction department of Henry L. Doherty & Company, has taken a position with the Foster Wheeler Corporation.

Raymond Gordon and Karl Jacobs, formerly of the construction department of the Detroit Edison Company, have been transferred to the production department at the Trenton Channel generating station. Kenneth Leipprandt has been transferred from the construction department of the company to the research department.

C. S. Tucker was recently installed as president of the Birmingham, Ala., chapter of the National Association of Power Engineers. E. F. Logan and Curt Nilsson were also installed as vice-president and secretary respectively.

A. H. Heitzler, for the past five years division manager at Lorain, Ohio, for the Ohio Public Service Company, is now superintendent of the electric department of the Public Service Company of Colorado, following his transfer to Denver. Harry H. Kerr, whose former position Mr. Heitzler now occupies, was promoted to superintendency of electric operation for the Toledo Edison Company, with headquarters at Toledo, Ohio.

A. Rogen, chief engineer of the municipal power plant at Granite Falls, Minn., has resigned to become superintendent of the municipal plant at Manilla, Iowa.

L. E. Baldwin, formerly head of the engineering department of the Florida Power Corporation, at St. Petersburg, Fla., has been appointed chief engineer of the United Power & Light Corporation, with headquarters at Abilene, Kan.

George Summers has been appointed general manager of the Stirling Boiler Company, Ltd., of London, England, with which he has been associated for over twenty years.

Auguste G. Pratt, president of the Babcock & Wilcox Company of New York City, has recently returned from a trip to Europe.

Business Notes

Chicago Pump Company, Chicago, Ill., announces the addition of Charles P. Hery to its list of representatives. Mr. Hery will have charge of the Rochester, N. Y., territory, with offices in the Cutler Building.

Square D Company, Detroit, Mich., has transferred J. J. Mitchell from the Cleveland office to the general offices and placed him in charge of all the company's panelboard sales. M. W. Parmalee has been appointed branch sales manager in Cleveland to succeed Mr. Mitchell. R. C. Thompson succeeds Mr. Parmalee as sales representative in Cleveland.

Steam & Combustion Company, 205 West Wacker Drive, Chicago, Ill., has been incorporated for the production and sale of gas-fired boilers and kindred lines. The company is owned and operated by the G. W. Dulany Trust, Chicago. G. W. Dulany, Jr., is chairman of the board; C. B. Page, president; W. E. Eberhart, vice-president and treasurer; J. E. Moore, secretary. The gas-fired boilers now being placed on the market are produced in association with the Freeman Manufacturing Company, Racine, Wis., and the National Machine Works, Chicago.

Republic Brass Corporation of New York City changed its name on Nov. 12 to Revere Copper & Brass, Inc., in honor of Paul Revere, who founded the business in 1801. Paul Revere was one of the first men in the world to roll copper, and his firm the first American copper-rolling company.

Metallurgical Laboratories, Inc., 1116 W. Montgomery Ave., Philadelphia, Pa., announces the establishment of a fully equipped plant and fabricating shop for the heat-treatment of metals. Horace C. Knerr, consulting metallurgical engineer, is president of "Metlab."

Trade Catalogs

Electric Wiring — The Crouse-Hinds Company, of Syracuse, N. Y., has just issued catalog No. 2200, which supersedes all previous listings of condulets, groundulets, plugs and receptacles. Complete data and price lists on all types of these products are given in the 280-page, cloth-bound volume.

Soot Cleaners—An extensive treatise on soot cleaning is given in a 38-page bulletin recently published by the Vulcan Soot Cleaner Company of Du Bois, Pa. Profusely illustrated, the publication covers the subject from the need for soot cleaning, through constructional details of cleaners to plant layouts.

Blowers — Types RSB and RBB rotary positive blowers of medium capacities at normal pressures up to 10 lb. per square inch are described in bulletin No. 123 issued by the Connersville Blower Company, of Connersville, Ind.

Diesel Engines—A brief history of the municipal electric light plant at Swift Current, Saskatchewan, by Charles P. Town, chief engineer of the plant, is presented in a recent leaflet of the Busch-Sulzer Bros.-Diesel Engine Company, St. Louis, Mo. Valuable operating data are included.

Waterwheels — Bulletin W207 of The James Leffel & Company, Springfield, Ohio, illustrates a distinctive type of self-contained, vertical, waterwheel generating unit for low and medium heads.

Pyrometer—A complete description of the Wilson-Maeulen potentiometer recording pyrometer is given in an 8-page illustrated booklet just issued by the Wilson-Maeulen Company, 383 Concord Ave., New York City.

Protective Coatings—Bulletins 1180 and 1181 of the Dampney Company of America, Hyde Park, Boston, Mass., describe methods used in fifty recent large water-tube boiler installations, totalling over 200,000 hp., to free water and steam surfaces from mill-scale.

With the Society Sections

A. S. M. E., Metropolitan Section. Power meeting, Nov. 21, Engineering Societies Building, Room 501, at 8:00 p.m. Subject: "Experiences in Chlorinating Condenser Circulating Water," by V. M. Frost, assistant to general superintendent of generation, and W. F. Rippe, test engineer at Kearny, both of the Public Service Electric & Gas Company, Newark, N. J.

A. S. M. E., Ontario Section. Meeting, Dec. 6, Galt, Ont., at 8 p.m. Subject: "Vertical Air Compressors," by George Oman of the Babcock-Wilcox & Goldie-McCulloch Company. A trip through the Babcock plant in the afternoon and dinner in Galt will precede the address in the evening.

A. S. M. E., Susquehanna Section. Meeting, Nov. 25, in rooms of the Engineering Society of York, Polack Bldg., York, Pa., at 8:15 p.m. Subject: "Simplified Practice and Its Effect on Cost of Production," by Edwin W. Ely, chief of Division of Simplified Practice, Department of Commerce, Washington, D. C.

A. S. H. & V. E., Boston Chapter. Meeting, Dec. 9. Subject: "Recent Development in the Control of Direct Steam Heating," by Webster Tallmadge, steam specialist, of New York City.

A. I. E. E., New York Section. Power Group Meeting, Dec. 9, Engineering Societies Building at 7:30 p.m. Subject: "Power System Connections."

Power Transmission Association. New York regional meeting, Nov. 22, at the Machinery Club, 50 Church St., New York City. Business session and illustrated talk, "Uni-Pull Drive," by John W. Skelley of the Rockwood Paper Pulley Stores, Inc.

Providence Engineering Society. Annual banquet, Nov. 20, at the Hotel Biltmore, Providence, R. I. Toastmaster, William McGregor; Speakers, Lt. Com. Charles E. Rosendahl, Prof. William H. Bristol, Dr. Clarence A. Barbour, Gov. Norman S. Case and Mayor James E. Dunne.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.15 @$2.50
Kanawha	Columbus	1.30 @ 1.60
Smokeless	Cincinnati	2.00 @ 2.25
Smokeless	Chicago	2.00 @ 2.25
S. E. Kentucky	Chicago	1.30 @ 1.60
Steam	Pittsburgh	1.50 @ 1.80
Gas Slack	Pittsburgh	1.00 @ 1.15
Big Seam	Birmingham	1.25 @ 1.50
Anthracite		
(Gross Tons)		
Buckwheat	New York	$3.00
Barley	New York	1.35@ 1.50

FUEL OIL

New York—Nov. 14, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—Nov. 8, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.596 per bbl. or 42 gal.; 26@28 deg., $1.646 per bbl.; 28@30 deg., $1.696 per bbl.; 30@32 deg., $1.746 per bbl.; 32@36 deg., gas oil, 5.026c. per gal.; 38@40 deg., distillate, 5.748c.

Pittsburgh—Nov. 12, f.o.b. local refinery, 30@34 deg., fuel oil, 4.87½c. per gal.; 36@40 deg., 5.12½c. per gal.

Philadelphia—Nov. 6, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — Nov. 5, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

Chicago—Nov. 9, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 80@85c. per bbl.; 26@30 deg., 95c.@$1.00 per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Nov. 11, tank-car lots, f.o.b., 12@14 deg., Baumé 4.25c. per gal.; 28@32 deg., 5.5c. per gal.

Dallas—Nov. 9, f.o.b. local refinery 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Crescent City—U. S. Government, Public Works Officer, 12th Naval Dist., 100 Harrison St., San Francisco, received lowest bid for the construction of a power house here from T. B. Goodwin, 2950 Divisadero St., San Francisco.

Calif., San Diego—San Diego State Teachers College, is having plans prepared for the construction of a training school building, power house and shop, etc. Estimated cost $130,000. G. B. McDougall, Public Works Bldg., Sacramento, is state architect.

Calif., Vallejo—Pacific Gas & Electric Co., 245 Market St., San Francisco, plans improvements to salt water generator No. 4. Estimated cost $200,000. Private plans.

Conn., Mansfield — State of Connecticut, F. Salmon, State House, Hartford, Comptroller, is having plans prepared for the construction of power house, laundry and infirmary at State Training School here. Estimated cost $250,000. Towner & Sellew, 363 Main St., Middletown, are architects.

Fla., Sarasota—J. N. McDonald, 714 First Bank & Trust Bldg., has been granted permit by Federal Power Commission, Washington, D. C., to construct a hydro-electric plant 16,000 hp. capacity on the Oklawaha River in Marion and Putnam counties. Estimated cost $1,000,000. G. L. Pratt, Citizens & Southern Bank Bldg., Atlanta, Ga., is engineer.

Idaho—U. S. Reclamation Bureau, plans the construction of a power plant on the Snake River, also dam, 130 ft. high and 700 ft. long on top for irrigation pumping project between Bliss and Glenns Ferry. Estimated cost $1,500,000.

Ill., Chicago—Physicians & Surgeons Institution of Chicago, c/o L. Guenzel, 879 North State St., Archt., awarded contract for the construction of a hospital including boiler room, two electric elevators, etc. at Maple and La Salle Sts. to McLennan Construction Co., 3-7 North Michigan Ave. Estimated cost $700,000.

Ill., Riverside — City will soon award contract for the construction of a pump house, etc. in connection with waterworks system. Estimated cost $100,000. Marr Green & Co., 400 North Michigan Ave., are engineers.

Ill., Roodhouse — Central Illinois Public Service Co., 130 South 6th St., Springfield, is having preliminary plans prepared for the construction of a sub-station here, also plans substations at Mundy and Rosiclare. $40,000. J. D. Roberts, c/o owner is chief engineer.

Ind., Attica — Company forming, c/o Universal Construction Co., 1925 Massachusetts Ave., Indianapolis, Contr. will build a 5 story hotel and sanitorium. Estimated cost $500,000. Steam heating system, etc. will be installed. This corrects report in Sept. 24 issue.

Ia., Muscatine—Bd. of Light Trustees, c/o J. F. Devitt, Chn., will receive bids until Nov. 19, for addition to power plant including one 1,000 hp. water tube boiler, one 100 ton coal bunker with two motor buckets, 5 ton ash conveying system, etc. Burns & McDonnell Engineering Co., 402 Interstate Bldg., Kansas City, Mo., are engineers.

Kan., Tecumseh—Kansas Power & Light Co., A. M. Patten, Pres., Topeka, will build addition to power plant including generating and boiler equipment, etc. Estimated cost $1,500,000. Private plans. Work will be done by day labor.

Me., North Eastport—Dexter Cooper Corp. Inc., D. P. Cooper, Pres., plans the construction of a hydro-electric development on Bay of Fundy. Estimated cost $100,000. Private plans.

Mass., Somerville (Boston P. O.) — Metropolitan Ice Co., 321 Washington St., taking bids for addition and alterations to ice plant on Leland St. Estimated cost $60,000. B. Gunlach, 597 5th Ave., New York, N. Y., is architect. R. B. Engineering Co., 11 West 42nd St., New York, is engineer.

Mass., Springfield—United Electric Light Co., 73 State St., plans the construction of a power sub-station in Forest Park District. Architect not selected.

Mich., Detroit—Wayne County, c/o County Rd. Commission, 3800 Barlum Tower, received lowest bid for the construction of a power plant building including power equipment, coal and ash handling equipment, etc., for county airport at Middle Belt and Goddard Rds. from Gallagher-Flemming Co., 6500 Epworth Blvd. $62,162.

Mich., Ontonagon—Northern Acquisition Co., awarded contract for the construction of a dam, 565 ft. at crest, 130 ft. high, also power plant, 20,000 hp. capacity to Prices Bros., Harries Bldg., Dayton, O. Estimated cost $1,285,000.

Mich., South Haven — City is having plans prepared for the construction of a sewage disposal plant including pumping station, etc. Estimated cost $200,000. S. H. Smith, City Hall, is engineer.

N. J., Hillsdale — Dept. of Institutions & Agencies, State Office Bldg., Trenton, awarded contract for the construction of a power house at Hillside Hospital to Delaware Form Co., 1001 Chestnut St., Philadelphia, Pa. Estimated cost $50,000.

N. Y., Brooklyn—Brownsville and East New York Hospital, will build a boiler room, laundry, etc. at Ave. A. and Rockaway Parkway. Estimated cost to exceed $40,000. E. M. Adelsohn, 26 Court St., is architect. Work will be done by separate contracts.

N. Y., Brooklyn—Rubel Coal & Ice Co., 937 Fulton St., will receive bids after Dec. 10, for the construction of an ice manufacturing plant at 21st St. and Neptune Ave. Estimated cost $90,000. H. J. Nurick, 44 Court St., is architect.

N. Y., New York—Holler Ice Mfg. Co., Reeds Mill Lane and Hollers Ave. is having plans prepared for the construction of an 80 x 150 ft. ice plant, Sibley & Fetherston, 205 East 42nd St., New York, are architects.

N. Y., Rochester—Dept. of Mental Hygiene, Capitol, Albany, awarded contract for the construction of a power house at Rochester State Hospital here to Grosline & Sawn, Rochester. Estimated cost $200,000.

O., Cleveland — Western Reserve University, 10940 Euclid Ave., had plans prepared for a 1 story coal and ash handling plant to include 21 x 57 ft. pit and tunnel 132 ft. long, coal and ash handling equipment, etc. on Cunningham Rd. Estimated cost $40,000. Wilbur Watson & Associates, 4614 Prospect Ave., are engineers.

O., Delta—City voted $125,000 bonds for the construction of a waterworks system including reservoir, pumping station, etc. H. P. Jones & Co., 1606 Independent National Bank Bldg., are engineers.

Pa., Pittsburgh — Union Storage Co., J. F. Porter, Pres., Boulevard of Allies, awarded contract for changing present power plant from steam to electrically driven to S. M. Siesel Co., Forbes Bldg. Estimated cost $100,000.

Pa., Warren—Warren State Hospital, H. W. Mitchell, Supt., plans the construction of a power house, sewage disposal plant, etc. in Warren Co. Estimated cost $64,762. J. E. Woodwell, 501 5th Ave., New York, N. Y., is engineer.

Tenn., Kingsport—Holston Power Co., c/o American Cyanamid Co., 535 5th Ave., New York, N. Y., Mr. Stowell, Ch. Engr., plans completed and making testing borings for dams and hydro-electric development near Kingsport and Johnson City. Private plans.

Washington—Northwestern Electric Co., has been granted permit by Federal Power Commission for the construction of power projects at Ariel and Yale. Work will be started in spring on first unit, estimated to cost $9,000,000. Cost of ultimate development $50,000,000.

B. C., Powell River—Powell River Co. Ltd., Vancouver Island, is receiving bids for the construction of a hydro-electric development, 18,000 hp. capacity on the Lois River here, to include dam, and tunnel, 5,800 ft. long. Estimated cost approximately $6,000,000. When completed company plans to build a second paper manufacturing plant.

Ont., Harrow—City Council, R. C. Flood, Clk., plans an election Nov. 26, to vote $56,000 bonds for waterworks improvements including electrically operated pumping equipment, etc. A. W. Connor, Metropolitan Bldg., Toronto, is engineer.

Ont., Woodstock—Dept. of Public Works, G. Hogarth, Secy., Toronto, plans addition to hospital building, also house power house and central heating plant at Hospital grounds. Estimated cost $100,000. Private plans.

Equipment Wanted

Pump and Motor—Houston, Tex.—City, c/o W. E. Monteith, Mayor, will receive bids until Dec. 4, for one 4,000 g.p.m. sewage pump with motor and accessories for Scott St. pumping plant.

Pumping Equipment—Los Angeles, Calif.—County Mechanical Dept., pumping equipment including 1,250 g.p.m. unit to operate against a total head of 265 ft. for Waterworks District 13, at Lomita.

Pumping Unit, etc.—Midlothian, Tex.—City will readvertise for new bids for pumping unit, etc. for proposed waterworks improvements.

Pumps, etc.—Jacksonville, Ill.—City will receive bids about Jan. 1, for pumps, etc. for proposed sewage treatment works. Estimated cost $596,000.

Industrial Projects

Calif., Hughson—Hughson Condensary, W. H. Low, Mgr., will build a condensary and milk receiving building, dry milk plant, boiler house, etc. Estimated cost $75,000.

Calif., Los Angeles — Northrop Aircraft Co., subsidiary of United Aircraft Corp., plans the construction of first two units of plant, 60 x 180 ft. factory and 30 x 50 ft. office at United Airport.

Calif., San Francisco — Link-Belt, Meese & Gottfried Co., 3100 19th St., manufacturers of machinery, awarded contract for the construction of a factory at Paul and San Bruno Aves. to Austin Co. of California, Russ Bldg., San Francisco. Estimated cost $400,000.

Conn., Meriden—International Silver Co., 48 State St., will soon award contract for a 1 and 3 story, 55 x 320 ft. factory. Estimated cost $100,000. Private plans.

Mass., Springfield—Moore Drop Forging Co., 356 Birnie St., awarded contract for a 1 story, 95 x 180 ft. addition to factory to Adams & Ruxton Construction Co., 1387 Main St. Estimated cost $45,000.

Mich., Detroit — O. L. Anderson Co., 1347 East Fort St., is having plans prepared for the construction of a 1 story stamping plant on Evergreen Rd. Estimated cost $175,000. Private plans. Equipment for the manufacture of metal stampings, metal tanks, etc. will be required.

Mich., Detroit—Detroit Show Case Co., 1654 West Fort St., awarded contract for a 2 story, 60 x 130 ft. factory to Gallagher-Fleming Co., 6500 Epworth Blvd. Estimated cost $45,000.

Mich., Muskegon—Clark Sanding Machine Co., c/o Chamber of Commerce, will build a 1 and 2 story, 80 x 450 ft. sanding machine factory at Industrial District. L. J. Hallburg, 116 South Michigan Ave., Chicago, Ill. Work will be done by owners forces. Electric motors and machine equipment will be required.

Mich., Muskegon—Filzjohn Mfg. Co., Central Ave., awarded contract for the construction of a 1 story, 90 x 100 ft. addition to factory for the manufacture of automobile bodies to Strom Construction Co., 357 Houseman Bldg., Grand Rapids. Estimated cost $40,000. Electric motors, etc. will be required.

Mo., St. Louis—Herman Body Co., Clayton and Newstead Aves., awarded contract for the construction of a 1 story, 163 x 130 ft. factory at 4416 Clayton Ave. to Murch Bros. Construction Co., 1759 Railway Exchange Bldg.

O., Cleveland—Cleveland Wax Paper Co., H. L. Fredrichs, Pres., 2217 Scranton Rd., awarded contract for a 1 story, 90 x 120 ft. factory at Berea and Triskett Rds. to S. W. Emerson Co., 1836 Euclid Ave. Estimated cost $50,000.

O., Cleveland—Columbia Metal Stamping & Die Co., F. C. Koch, Pres. and Gen. Mgr., 1536 East 49th St., awarded contract for a 1 story, 90 x 220 ft. factory at East 116th and Harvard Sts. to J. L. Hunting Co., Guarantee Title Bldg. Estimated cost $125,000.

O., Medina—A. I. Root Co., (woodworking) A. I. Root Co., awarded contract for a 1 story, 90 x 200 ft. factory to Austin Co., 16112 Euclid Ave., Cleveland. Estimated cost $60,000.

Pa., Bradford—Waddington Tractor & Equipment Co., C. E. Waddington, 17 Webster St., awarded contract for a 2 story, 30 x 60 ft. factory on Congress St. to Simonsen & Lundgren, 106 Elm St.

Tenn., Kingsport—American Cynamid Co., 535 5th Ave., New York, N. Y., Mr. Stowell, Ch. Engr., plans the construction of an electrochemical plant here. Private plans.

Wyo., Conroy — Wyoming Carbonizing & Briquetting Corp., c/o C. Peter, Mgr., Newhouse Bldg., Salt Lake City, Utah, is having plans prepared for the construction of a carbonizing and briquetting plant, 1000 ton capacity here. Estimated cost $1,500,000. K. A. Loven, Buckingham Hotel, Minneapolis, Minn., is engineer.

Ont., Toronto—Canadian Paper Board Co., 2 Seigneurs St., Montreal, Que., awarded contract for a 1 story, 108 x 162 ft. addition to paperboard mill to Stevens Engineering Co., 25 St. Patrick St., Toronto, Ont. Estimated cost $100,000.

Wis., Milwaukee — Pressed Steel Tank Co., Greenfield Ave., awarded contract for a 1 story, 54 x 192 ft. factory to Wisconsin Bridge & Iron Co., North Milwaukee St.